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CITIZEN EVACUATION IN RESPONSE TO NUCLEAR AND NONNUCLEAR THREATS

FINAL REPORT

Ronald W. Perry

SEPTEMBER 1981

Prepared under Contract EMW-C-0296, Work Unit Number 4821F, Federal Emergency Management Agency, Washington,D.C. 20472

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FINAL REPORT
Work Unit 4821f

BY

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for

FEDERAL EMERGENCY MANAGEMENT AGENCY
Washington, D.C. 20472

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This study represents an initial step in support of the concept of comprehensive emergency management by comparing evacuations in nuclear and nonnuclear threats. Two issues in particular are examined: (1) citizen warning source and perceived credibility of warnings; and (2) citizen evacuation decision-making processes. We review citizens source of first warning, and perceived credibility of different warning (over)

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sources. Cross-hazard comparisons are made among total evacuees, reasons given for evacuating and not evacuating, and citizen beliefs about the nature of the threat.

Three types of hazard are chosen for comparisons: nuclear, volcano and riverine flood. The nuclear emergency used for analysis was the March 28, 1979 reactor accident at Three Mile Island (TMI), Pennsylvania.

With regard to warning source, in the case of TMI most respondents first heard of the incident via mass media; virtually all others reported they first heard from a personal or nongovernemental source. Almost no respondents cited officials as a first source. The pattern of first information receipt in natural disasters was quite distinct. Most citizens heard first from emergency response authorities, and the next most frequently cited source was personal contacts. The mass media accounted for only a small proportion of first contacts.

In comparisons of public confidence in information sources, the important finding was that at TMI the public perceived the mass media as most reliable, while in the nonnuclear disasters public confidence was highest in local emergency response authorities.

Citizen belief in real situational danger and advisories from officials were the most frequently cited reasons for leaving among evacuees in both the nuclear and nonnuclear incidents. Also, for both TMI and the natural disasters, most of those who chose <u>not</u> to evacuate said that they believed they were in no real danger. Among nonevacuees at TMI, conflicting messages and the absence of an official evacuation order were frequently cited as reasons for staying. In the natural disasters, citizens also reported that they chose to not evacuate in order to protect their homes.

Finally, the implications of the findings for evacuation planning and operations are assessed.

ACKNOWLEDGEMENT

The data on natural disasters used in this report were collected and initially analyzed in connection with grants from the Division of Civil and Environmental Engineering of The National Science Foundation. Grant number PFR-77-23697 supported the studies of riverine flood evacuations, and a supplement to that grant supported the subsequent study of the evacuations during the May 18, 1980 eruption of Mt. St. Helens volcano in Washington State. The opinions and conclusions drawn from these data bases are those of the author and do not necessarily reflect official National Science Foundation Policy.

EXECUTIVE SUMMARY

The study represents one initial research step in support of the concept of comprehensive emergency management (CEM). Comprehensive emergency management refers to the problem of developing a capability for handling all phases of activity--mitigation, preparedness, response, and recovery--in all types of disasters by coordinating the efforts of many different agencies (cf. National Governor's Association, 1979:11). Thus, an important aspect of CEM is the concept of managing a variety of types of disaster: it emphasizes an "all hazards" approach for FEMA. In turn, this dictates a concern on the part of managers with developing methods and concepts which are applicable across numerous disasters, both natural and man-made. In support of this goal, the FEMA sponsored National Academy of Sciences Committee on United States Emergency Preparedness has begun to lay the theoretical and conceptual foundations for making such cross-hazard comparisons. A large part of this effort has involved identifying common or generic functions which must be accomplished in managing emergencies--i.e., evacuation, search and rescue, warning dissemination, sheltering, rehabilitation, public information, etc.--and discussing, based upon historical case studies, the applicability of each function across different types of disasters. In developing a capability for CEM, the logical extension of this work is to begin examining specific functions and making systematic, data-based comparisons among different types of disasters. In this way, one can build a body of information which documents similarities and differences in human performance relative to specific functions for numerous disasters.

The present report focuses upon one generic function, evacuation, and makes comparisons among two natural disasters and one nuclear disaster. An important goal of this work is to begin laying the empirical groundwork for making further comparisons regarding evacuation response with still other types of disasters. This report is not directly aimed at providing incident-specific guidance for emergency managers. Instead, it is meant to serve as an initial step toward building a body of data-based comparisons which can subsequently be examined and integrated into a data-bank for use by emergency planners. At present the scientific and technical literature contains no systematic empirical comparative studies of human response to different disaster agents. In this report a very simple model for making such comparisons about evacuation behavior is used as a starting point for developing more complex models in subsequent analyses. It is to be emphasized that this work represents a beginning point in constructing what can eventually be a larger body of generalizations about human performance under different disaster conditions which can be used in developing comprehensive emergency management strategies. Its optimal value, therefore, rests not so much in the results of these comparisons alone, but in its integration with future similarly comparative studies.

The purpose of this report is to describe the results of a comparative analysis of data on citizen evacuation behavior in response to nuclear and nonnuclear threats. Two issues in particular are examined: (1) citizen warning source and perceived credibility of warnings; and (2) citizen evacuation decision-making. We review citizens' source of first warning, the relative utility of warning

information, and the perceived reliability of different warning sources. Then, cross-hazard comparisons are made among the total numbers of citizens who evacuate, reasons given for evacuating or not evacuating and citizen beliefs about the nature of the threat to their families.

Comparisons are made among three types of hazard: nuclear, volcano, and riverine flood. The nuclear hazard involves evacuation behavior after the accident which occurred at the Three Mile Island nuclear plant on March 28, 1979. Three studies serve as our primary sources of data on this incident: (1) a comprehensive telephone survey of area residents sponsored by the Nuclear Regulatory Commission (Flynn, 1979); (2) a mailed survey sponsored by Rutgers University and conducted by that institution's geography department (Barnes et al., 1979); and (3) a mailed survey sponsored and conducted by the geography department at Michigan State University (Zeigler et al., 1981). While a number of studies of Three Mile Island were reviewed, data were selected from the above three to use in secondary analysis. Each of these studies is based upon probability samples of citizens living within a specified radius (distance) of the Three Mile Island reactor.

The data on volcano hazard are drawn from a study of evacuation response in a community threatened by the May 18, 1980 eruption of Mt. St. Helens in Washington State (Greene et al., 1980; Perry et al., 1980a). Data on three community evacuations conducted in response to riverine floods are drawn from Battelle Institute archives (Perry et al., 1980b), based upon research sponsored by the National Science Foundation. All of the natural hazard response studies are also based upon probability samples of community residents.

The report is structured around five chapters. The first presents a review of past attempts to compare nuclear and nonnuclear threats, and develops an explicit logic for making such comparisons. This is followed by a section which gives a brief overview of each of the disaster events to be compared. The next two chapters address, in turn, comparisons of warning source credibility and evacuation decision-making among the nuclear and nonnuclear threats. Finally, the last chapter examines the implications of the findings for the problem of evacuation planning.

Comparing Nuclear and Nonnuclear Threats

This report argues that emergency management and citizen response to nuclear threats can appropriately be examined within the same conceptual and analytic framework as any other disaster agent, whether natural or man-made. The same basic definition of disaster encompasses a broad spectrum of disaster events and when definite characteristics of disasters are examined, it was found that natural hazards differ as much among themselves as from nuclear hazards. Thus, there appears to be no substantial theoretical reason for treating nuclear disasters as a phenomenon which is incomparable to other events characterized as disasters in the research literature.

It is not argued that all disasters are basically the same or that they have similar consequences. It is acknowledged that nuclear disasters, like all disaster agents, possess some unique characteristics. The most unique aspect of a nuclear power plant accident is that a threat which cannot immediately be seen, heard, or felt--radiation--is involved. Thus, some attention is necessary because, in terms of the way people perceive the situation, such circumstances are different from those which accompany other disaster agents. Research

indicates that some of the public view nuclear energy, and most applications of it, as a particularly threatening hazard with the potential for extraordinarily long-term negative effects. The idea that people have a different "mind set" for nuclear disasters certainly does not preclude comparisons with nonnuclear disasters. Instead, it simply requires that this perceptual dimension and the emotional response to it be acknowledged and that necessary qualifications be made when such differences may have some bearing upon human performance.

The Disaster Events

This chapter gives a review of five threats: the May 18, 1980 eruption of the Mt. St. Helens volcano in Washington State; three riverine floods which occurred in the Western United States between December, 1977, and March, 1978; and the nuclear reactor accident at Three Mile Island, Pennsylvania, which began March 28, 1979. Descriptive data are presented on each of the disaster events and a largely nontechnical account of the circumstances surrounding disaster impact is related. The purpose of these descriptions is twofold: to provide an overview of the disaster incident and to convey general information which will make interpretations and comparisons between events more meaningful.

Comparisons of Warning Source and Credibility

This chapter presents an analysis of the sources from which citizens first received disaster information and their evaluation of the credibility of different sources of information about the threat. The majority of respondents--69%--reported that they first heard of the TMI accident from the mass media; virtually all others first heard from a

personal, non-governmental contact--primarily friends, neighbors, relatives or job colleagues. Almost no one cited an official--emergency management authority or general government--source as the place from which they initially heard about the accident. The pattern of first information receipt in natural disasters was quite distinct: most people--about 50%--heard first from emergency response authorities, and the next most frequently cited first source was personal contacts. The mass media accounted for only a small proportion of the first contacts.

To a certain extent, the differences in patterns of first warning source between TMI and the natural disasters may be understood in terms of the low forewarning at TMI. However, the differences point to an important distinction in the pattern of who controls the emergency response to the natural disasters versus the TMI case. In the natural disasters control and communication tend to remain with local authorities and the mass media play a less distinct role during the emergency period. Two important factors in this control are that in natural disasters: (1) technical status reports on the hazard go from experts to emergency response authorities who incorporate the information into their planning and interpret the data for the public, and (2) those emergency response authorities are traditionally visible to and recognized by the public as responsible for protecting the citizenry. The consequence of having visible emergency response authorities in control is that it enables the public to define more easily the disaster as an event which can be managed to an acceptable outcome.

The finding that most respondents first heard about TMI via the mass media foreshadowed the subsequent reliance on the mass media as a primary communication channel to the public. Many factors influenced public perceptions of the emergency response efforts at TMI, including high visibility of political figures coupled with lower visibility of traditional emergency response personnel, and real conflict among responder agencies. The use of the media, however, as a main channel of communication to the public probably exacerbated (and no doubt sometimes exaggerated) problems of control.

In the comparisons of public confidence in information sources, the important finding was that at TMI the public perceived the mass media as the most reliable source, while in the nonnuclear disasters the public placed highest confidence in local emergency response authorities.

Evacuation Decision-Making

Citizen belief in real situational danger and advisories from officials were cited most frequently as the critical reasons for evacuating in both the nuclear and nonnuclear incidents. Indeed, these two reasons alone account for more than 55% of the volcano evacuees, 69% of the flood evacuees, and nearly 45% of the evacuees at TMI. Interestingly, mass media warnings were infrequently chosen as the most important reason for evacuating in all three types of hazard. It was found, however, that social network contacts were relatively more important to evacuation decision-making in the natural disasters than at Three Mile Island.

For both TMI and the natural disasters, most of those citizens who did not evacuate chose not to because they did not believe that a real danger existed. Among non-evacuees at TMI, the presence of conflicting messages and the absence of an official evacuation order were frequently cited reasons for staying. In the natural disasters, people also reported that they chose to stay so that they could protect their homes from the environmental threat. Unlike the natural disasters, fear of looting was given as a reason for not evacuating at TMI.

Finally, this chapter concludes with a detailed examination of why so many people spontaneously evacuated at TMI. It is argued that the evacuations can be explained in terms of two general categories of reasons: (1) largely circumstantial factors related to the way the emergency was managed; and (2) factors related to the public's perception of the risks involved in nuclear accidents. The evidence marshalled in this report suggests that once we allow for the fear or dread characteristics associated with nuclear disasters, the evacuation response at TMI can be explained using the same model developed to understand evacuation behavior in other natural and man-made hazards. The rudimentary model suggests that citizens evacuate when four conditions are met: (1) they have accounted for the safety of their immediate household; (2) they have been given--by authorities--or have personally developed a plan for protective action; (3) they believe that a threat does exist in the environment; and (4) they perceive that upon impact this threat could result in some level of damage to their person, family and property. At Three Mile Island the nuclear nature of the

threat meant that people perceived personal risk to be very high (condition four), but in general those who evacuated were people for whom all four conditions were met.

Implications for Evacuation Planning

Nine general conclusions are elaborated in this chapter which have implications for the conduct of evacuation planning:

- During the course of a nuclear reactor emergency, local emergency response authorities should be integrated into the public information system and should constitute the public's primary source of accident-relevant information.
- When an emergency--either nuclear or nonnuclear--is in progress, the mass media should not be relied upon as a primary communication channel to the public.
- When an emergency is in progress, officials should distinguish the function of providing public information about the emergency from the function of sending messages which direct some emergency response.
- In all disasters, particularly nuclear disasters, rumor control is a critically important function.
- The public information function is a particularly important component of emergency response plans for dealing with nuclear power plant accidents.
- The "dual use" philosophy appears to be founded upon reasonable assumptions in that the basic principles of human response to natural hazards also describe human response to nuclear threats.

- Inter-organizational and inter-agency coordination and preparedness for ordering and over-seeing a mass evacuation are crucial problems in both nuclear and nonnuclear disasters.
- The high level of spontaneous evacuations around TMI appears to be related to the public's elevated perceptions of levels of personal risk associated with radiation threats.
- Citizen evacuation response during nuclear disasters may be understood in terms of the same variables which explain evacuation decision-making in nonnuclear disasters.

This chapter elaborates the reasoning behind each of the general conclusions and derives specific corollaries applicable to the conduct of emergency planning and operations.

Finally, a number of implications of the present study for further research are discussed. Three general, and several specific studies are suggested: (1) a study of how research results are disseminated from researchers to planners and policy-makers, as well as how these latter actors evaluate and incorporate research information into the emergency management process; (2) a study of the calculus used by citizens in assessing risks associated with radiation relative to other hazards; and (3) studies of the design and implementation of both public information programs regarding nuclear disasters and dissemination programs for specific emergency response plans.

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CHAPTER ONE

INTRODUCTION

The study represents one initial research step in support of the concept of comprehensive emergency management (CEM). Comprehensive emergency management refers to the problem of developing a capability for handling all phases of activity--mitigation, preparedness, response, and recovery--in all types of disasters by coordinating the efforts of many different agencies (cf. National Governor's Association, 1979:11). Thus, an important aspect of CEM is the concept of managing a variety of types of disaster: it emphasizes an "all hazards" approach for FEMA. In turn, this dictates a concern on the part of managers with developing methods and concepts which are applicable across numerous disasters, both natural and man-made. In support of this goal, the FEMA sponsored National Academy of Sciences Committee on United States Emergency Preparedness has begun to lay the theoretical and conceptual foundations for making such cross-hazard comparisons. A large part of this effort has involved identifying common or generic functions which must be accomplished in managing emergencies--i.e., evacuation, search and rescue, warning dissemination, sheltering, rehabilitation, public information, etc.--and discussing, based upon historical case studies, the applicability of each function across different types of disasters. In developing a capability for CEM, the logical extension of this work is to begin examining specific functions and making systematic, data-based comparisons among

different types of disasters. In this way, one can build a body of information which documents similarities and differences in human performance relative to specific functions for numerous disasters.

The present report focuses upon one generic function, evacuation, and makes comparisons among two natural disasters and one nuclear emergency. An important goal of this work is to begin laying the empirical groundwork for making further comparisons regarding evacuation response with still other types of disasters. This report is not directly aimed at providing incident-specific guidance for emergency managers. Instead, it is meant to serve as an initial step toward building a larger body of data-based comparisons which can subsequently be examined and integrated into a data-bank for use by emergency planners. At present the scientific and technical literature contains no systematic empirical comparative studies of human response to different disaster agents. In this report a very simple model for making such comparisons about evacuation behavior is used as a starting point for developing more complex models in subsequent analyses. It is to be emphasized that this work represents a beginning point in constructing what can eventually be a larger body of generalizations about human performance under different disaster conditions which can be used in developing comprehensive emergency management strategies. Its optimal value, therefore, rests not so much in the results of these comparisons alone, but in its integration with future similarly comparative studies.

To date, social scientific examinations of the question of the comparability of human response to nuclear and nonnuclear hazards have been largely at a theoretical level. Those who believe that response to

nuclear disasters will be different have based their arguments upon the presumed unique nature of the disaster agent: the radiological component, the potentially huge magnitude of negative consequences, extended secondary effects, and lack of public experience with such disasters. Thus, the emphasis is upon the disaster agent itself.

On the other hand, it has been demonstrated that one can focus upon generic functions in disasters and develop a strategy for making comparisons among different disaster agents based upon the ways in which these functions are conducted. In adopting this approach, research emphasis shifts away from concern with cataloguing ways in which disaster agents are alike or different, and focuses upon assessing ways in which function-related human behaviors compare between nuclear and nonnuclear disasters. This emphasis upon analyzing "functions" allows the investigator to focus upon the relevant issue of commonalities or differences in human response.

In this report, we have adopted the latter strategy and focus upon the function of population evacuation. This report examines two issues in particular: (1) citizen warning source and perceived credibility of warnings; and (2) citizen evacuation decision-making. We review citizens' source of first warning, the relative utility of warning information, and the perceived reliability of different warning sources. In looking at evacuation decision-making, cross-disaster comparisons are made among the total numbers of citizens who evacuate, reasons given for evacuating or not evacuating and citizen beliefs about the nature of the threat to their families.

Comparisons are made among three types of disaster, one nuclear and two nonnuclear. The nuclear hazard studied involves evacuation behavior after the accident which occurred at the Three Mile Island nuclear power plant on March 28, 1979. Three studies serve as our primary sources of data on this incident: (1) a comprehensive telephone survey of area residents sponsored by the Nuclear Regulatory Commission (Flynn, 1979); (2) a mailed survey sponsored by Rutgers University and conducted by that institution's geography department (Barnes et al., 1979); and (3) a mailed survey sponsored and conducted by the geography department at Michigan State University (Zeigler et al., 1981). While a number of studies of Three Mile Island were reviewed, data were selected from the above three to use in secondary analysis. Each of these studies is based upon probability samples of citizens living within a specified radius (distance) of the Three Mile Island reactor.

The two types of nonnuclear disasters examined in this report are volcanoes and riverine floods. The data on volcano hazard are drawn from a study of evacuation response in a community threatened by the May 18, 1980 eruption of Mt. St. Helens in Washington State (Greene et al., 1980; Perry et al., 1980a). Data on three community evacuations conducted in response to riverine floods is drawn from Battelle Institute archives (Perry et al., 1980b) to be used in the comparative analyses. All of the natural hazard response studies are also based upon probability samples of community residents.

The remainder of this report is structured around five chapters. The first presents a review of past attempts to compare nuclear and nonnuclear threats, and explicitly develops a logic for making such

comparisons. This is followed by a section which gives a brief overview of each of the disaster events to be compared. The next two chapters address, in turn, comparisons of warning source credibility and evacuation decision-making among the nuclear and nonnuclear threats. Finally, the last chapter examines the implications of the findings for the problem of evacuation planning.

CHAPTER TWO

COMPARING NUCLEAR AND NONNUCLEAR THREATS

To date, there have been very few attempts to make systematic comparisons of human response to different types of disaster agents. Indeed, there has been a general reluctance to apply findings about human behavior from one type of natural disaster to another; the matter of comparing nuclear with nonnuclear threats did not begin to appear in the professional literature at all until the late 1970's.

In part, this condition reflects the fact that historically a large component of disaster studies has been journalistic and descriptive in nature (Gillespie and Perry, 1976:303). Hence, attention has often been focused upon the disaster event itself--the hurricane or the earthquake--and descriptions of specific consequences of the disaster for victims. The literature reported, then, on earthquake victims crushed under rubble or burned by fires and hurricane victims drowned in the storm surge. In this context, many disaster researchers have argued that different disaster agents have different characteristics and impose different demands upon a community social system; thus, human reaction to different disasters is likely to be different. Such reasoning concentrates upon the disaster event itself and specifically focuses on the uniqueness of different events.

It is of course correct that disaster events at this level are all different; particularly in terms of the precise agent which imposes physical damage. However, this approach involves essentially a phenotypic classification system for disaster events, focusing upon the

surface or visible properties of each event. Carried to its logical extreme, such an approach would conclude that even all riverine floods possess certain unique characteristics, which technically implies that they are not fully comparable with one another.

In the past decade, there has been a transition in disaster studies toward an increased concern with the development of conceptual schemes for understanding and explaining human response to disaster. In so doing, research attention has turned from describing disaster events to understanding the demands and stresses resulting from disaster impact and cataloguing various strategies for coping with such demands and stresses. To effect this shift from examining the event to focusing upon human response requires that (1) a more systematic means of classifying disaster events be devised to promote (2) the delineation of common functions or demands imposed upon individuals and social systems as a consequence of disaster impact.

The purpose of the classification system is to characterize disasters, not in phenotypic terms, but in terms of features which have an impact on the kinds of protective or ameliorative measures that might be used in a mitigation program. In this way, one may choose a given function--for example, population warning--and examine the ways in which the task varies across different disaster events because of different disaster characteristics--such as the presence of a technology to detect the pending threat in advance or the speed of disaster onset once detected.

The following paragraphs develop a logic for classifying disasters in terms that facilitate effective comparisons of human response across different disaster agents. This review draws upon the classification schemes devised by Kreps (1979) and Perry et al. (1980c) for comparing natural disasters with nuclear attack. The scheme presented here is devised by examining the definition of disaster and isolating crucial dimensions for comparison. Finally, each of the three hazards of interest here--volcanoes, floods, and nuclear power plant accidents--are classified using the selected dimensions as the basis for comparison.

Classifying Disaster Events

Disasters are usually thought of as catastrophic events, frequently associated with the forces of nature: earthquakes, tornadoes, hurricanes, etc. Yet other events, such as explosions, chemical spills or industrial accidents, are also described as disasters. In establishing parameters for the social scientific study of disaster, Charles Fritz (1961:655) has advanced a definition which concentrates on important distinguishing features of disaster events. He suggests that a disaster is any event:

> . . . concentrated in time and space, in which a society or a relatively self-sufficient subdivision of society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented.

This classic definition stresses that disasters occur at a definite time and place and that they disrupt social intercourse for some period of time. Allen Barton (1970:38) proposes a similar definition, but chooses to focus upon social systems, arguing that disasters exist "when many

members of a social system fail to receive expected conditions of life from the system". Both Fritz and Barton agree that any event which results in a significant change in inputs or outputs for a given social system is accurately characterized as a disaster. The important point to be derived from inspecting these definitions is that volcanoes, hurricanes, floods, chemical spills, explosions, or nuclear power plant accidents all fit equally well into either definition. Hence, at this level of abstraction, both nuclear and nonnuclear disasters may be treated under the same conceptual rubric.

Given that nuclear and nonnuclear disasters may be subsumed under the same definitional umbrella, one can further specify the links betwen the two classes of events by comparing them in relation to known disaster characteristics in general. That is, one can specify how nuclear and nonnuclear disasters compare relative to important defining characteristics of disaster events.

There has been some discussion of how nuclear and nonnuclear disasters differ in the early literature on human response to natural disasters. Most of this work was done at the Ohio State University Disaster Research Center between 1963 and 1972 and focused upon the problem of assessing the implications of studies of natural disaster for the problem of nuclear attack (Kreps, 1979). One study, conducted by Anderson (1969) examines the functioning of civil defense offices in natural disasters and applies his findings to the nuclear attack environment. In developing his analysis Anderson argued that in spite of various differences between nuclear and nonnuclear disasters:

> . . . [these differences] can be visualized as primarily ones of degree. With the exception of the specific form of secondary threat, i.e. radiation, and the probability that a wider geographic area will be involved, a nuclear [disaster] would not create essentially different problems for community response (1969:55).

Therefore, Anderson began laying the basis of a scheme to compare nuclear with natural disasters by examining two important distinguishing features of disasters: the form of secondary impacts and the scope of impact.

Allen Barton (1970) advanced a classification scheme for disasters which builds upon the two distinguishing features used by Anderson. In his attempt to characterize the nature of social system stress Barton chose four basic dimensions: scope of impact, speed of onset, duration of impact, and social preparedness (1970:40-47). Scope of impact is a geographic reference categorizing impact as involving either a small area or only a few people (narrow impact), or as encompassing a large area or number of people (widespread impact). Speed of onset refers to the suddenness of impact or to the time period between detection of a hazard and its impact on the social system. This dimension is usually classified as either sudden or gradual. Duration of the impact itself refers to the time that elapses between initial onset of impact and the point at which it subsides. This can be a few minutes (short) in the case of a tornado, or several hours (long) in the case of some riverine floods. Finally, social preparedness is used in the context of possible forewarning to indicate whether or not the current state of technology permits authorities to anticipate or predict a threatened disaster impact.

In addition to the dimensions discussed by Barton, we will also retain Anderson's concept of secondary impacts in our scheme. Virtually all hazards, whether nuclear or nonnuclear, entail some secondary

impacts; in some cases the secondary impact is even more devastating than the initial or primary impact. Riverine floods tend to deposit silt and debris over inundated areas, earthquakes involve aftershocks and often result in urban fires, tropical cyclones leave great physical destruction, often creating public health risks. Nuclear power plant accidents potentialy involve radioactive atmospheric releases thereby producing a possibly very lingering secondary impact in the form of residual radiation.

By assembling lists of distinguishing characteristics such as those elaborated above, one can classify a range of disaster agents and be alerted to important distinctions among them. Table 1 classifies the three agents of interest in this report in terms of the five important defining characteristics.

It is interesting to note at the outset that volcanoes and nuclear power plant accidents are identically classified on all five dimensions for comparison. Both hazards involve a variable scope of impact, with volcanoes' negative effects usually extending a maximum of a few miles from the crater, and plume inhalation hazards associated with power plant accidents extending to an approximate 10 mile radius from the plant (cf. U.S. Nuclear Regulatory Commission, 1981). Under special conditions, however, the scope of impact may be considerably greater. The May 18, 1980 eruption of the Mt. St. Helens volcano spread volcanic ash over a three state area and a "worst-case" reactor accident involving a core melt could affect an entire region of the United States. The speed of onset for volcanoes and powerplant accidents is sudden, with no long period of threat before the initial impact. For both cases, the duration

TABLE 1

DISASTER AGENTS CLASSIFIED BY SELECTED
DEFINING CHARACTERISTICS

	Disaster Agent		
Defining Characteristics	Riverine Floods	Volcanoes	Nuclear Power Plant Accident
Scope of Impact	variable	variable	variable
Speed of Onset	gradual	sudden	sudden
Duration of Impact	long	long	long
Secondary Impacts	yes: public health problems; physical damage	yes: physical damage and public health	yes: public health (radiation)
Social Preparedness (Predictability)	yes	Detect but not predict	Detect but not predict

of impact is long. A volcanic eruptive sequence usually involves multiple eruptive events over a period of five to twenty years (MacDonald, 1972). The duration of impact for powerplant accidents is highly variable, but could involve several days (the danger period at TMI extended about 6 days). In absolute time, this is shorter than a volcanic eruption sequence, but both are of long duration compared to other hazards such as tornadoes, hurricanes, or tsunamis.

Both volcanic eruptions and power plant accidents generate secondary impacts. Human settlements near a volcano may experience lasting physical damage from any of several agents--lava flows, mud flows, large tephra, ash fall, or flooding--and the aftermath of this type of damage can create public health hazards due to polluted water supplies, waste disposal, etc. Power plant accidents which involve atmospheric releases of radiation produce potential secondary hazards associated with human inhalation and possible entry into the flood chain via animal ingestion.

Finally, with regard to social preparedness or predictability, the present state of technology is such that neither volcanic eruptions nor power plant accidents may be forecast in advance. There is, in both cases however, a technology for detecting events once they have occurred. In the case of some volcanoes, once an eruptive sequence has begun, either seismic or geochemical clues may be used to make approximate forecasts of eruptive events. With nuclear power plants, available technology is designed to detect minor aberrations early in the hope of taking correction action before more serious difficulties develop. Thus, while strictly speaking one cannot predict power plant accidents, the nature of the detection function is such that by detecting

malfunctions early, subsequent malfunctions which may eventually result in a serious atmospheric release may be anticipated (and perhaps prevented).

Riverine floods differ from volcanoes and power plant accidents primarily in terms of two of the defining characteristics: floods are predictable, usually some time in advance, and speed of onset is gradual, requiring 6 hours or more to reach a flood crest (Owen, 1977). Also, another general point of distinction is that floods occur more frequently than either volcanic eruptions or nuclear power plant accidents. Thus, from the standpoint of both the authorities and the public, riverine floods are a relatively familiar hazard, which can be predicted in advance, and that develop at a slow pace.

Like volcanic eruptions and power plant accidents, floods have a variable scope of impact, usually affecting only a few square miles, but potentially a much larger area. Riverine floods are characterized by a long duration of impact, usually a few days. Secondary impacts associated with riverine floods include physical damage to dwellings, damage to arable land due to silt and sand deposits, and associated public health hazards.

It has been argued above that one can appropriately examine a variety of disasters--specifically riverine floods, volcanoes and nuclear power plant accidents--within the same conceptual and analytic framework. The same basic definition subsumes all of the events, and they may be described using a single scheme for defining characteristics of disasters. Thus, a careful examination of the problem reveals no

significant conceptual reason for treating nuclear and nonnuclear hazards as fundamentally different such that they must be separated and examined using different frameworks in social scientific analysis.

Unique Aspects of Disaster Events

The preceding discussion was meant to demonstrate that logical and appropriate comparisons can be made among nuclear and nonnuclear threats; analytically, in terms of the present state of disaster research, there is no justification for isolating nuclear disasters in a class by themselves. This is not to say, however, that all hazards--whether nuclear or nonnuclear--do not involve some unique characteristics.

In conducting a comparative analysis, one must review and examine the implications of unique hazard characteristics for the human response variables of interest. In this case, our concern focuses upon one generic function performed in disasters: population evacuation. More specifically, we are interested in people's perceptions of warning source credibility and their reasons for evacuating. The following paragraphs briefly highlight several unique aspects of the nuclear hazard as a means of facilitating our comparative analysis by noting specific qualifiers which may be incorporated into subsequent data analyses.

As a disaster event, the most unique aspect of a nuclear power plant accident is that a <u>nuclear</u> component is involved. Thus, some attention is necessary because, in terms of the way people perceive the situation, such circumstances are different from those which accompany other disaster agents. Research indicates that some of the public views nuclear energy, and most applications of it, as a particularly

threatening hazard with the potential for extraordinarily long-term negative effects--literally the power to irreversibly destroy generations (Lindell, et al., 1978). Of course, the idea that people have a different "mind set" for nuclear disasters certainly does not preclude comparisons with nonnuclear disasters. Instead it only requires that this "emotional" dimension be acknowledged and that the necessary qualifications be made when such perceptual differences may have some bearing upon human performance.

Two aspects of this emotional dimension should be mentioned here: risk perception and experience. The agent of threat to the human population in a nuclear power plant accident is nuclear radiation. In contemporary American society, this agent is a high fear-generating mechanism regarding which the public at large is poorly informed (Kaplan, 1978; Rankin et al., 1978). Furthermore, surveys indicate that much of the information that the public does hold about nuclear power plants is technically incorrect (Earle, 1981). This situation produces an environment where some people potentially have exaggerated conceptions of the destructive potential of an accident, while others may believe that negative consequences are of less concern. Also, there is widespread disagreement on what constitutes a source of acceptable ("accurate") information about nuclear hazards, particularly power plants (Martin, 1980). Thus, public perception of danger associated with nuclear power plants is highly variable, and there are few sources of information perceived to be acceptable which might serve to promote a more homogeneous definition of threat. That is, through selective choice of information, individuals with extreme attitudes, whether exaggerating or

minimizing risks, can locate sources which reinforce their point of view. Such circumstances tend to exacerbate the problems associated with emergency planning and response.

The second aspect of the emotional response to nuclear disasters is that most citizens lack a reference point in their experience for such events. Only one reactor accident involving potential threat to offsite populations has occurred in the United States, and this involved an area of comparatively small size around Harrisburg, Pennsylvania. While the media coverage was extensive, the majority of the population has at best only vicariously experienced the power plant accident. Consequently, unlike the situation which prevails with natural disasters, one cannot expect people's "prior experience" with nuclear disasters to help them arrive at a definition of threat associated with a given nuclear disaster.

Indeed, the effects of the accident at Three Mile Island upon public perception of risks associated with nuclear power plant accidents are unclear. Three Mile Island was a localized threat, characterized by apparent confusion of all parties involved, a shortage of visible, strong official leadership and shrouded in conflicting accounts in the mass media (cf. Flynn, 1979; Chenault, et al., 1979; Sandman and Paden, 1979). In the short run, the incident produced two general consequences: (1) it resulted in intensive dissemination of a variety of information (some technically accurate and some not) regarding nuclear power plant safety; and (2) the apparent confusion and slow action initially on the part of officials raised doubts about the capability of authorities to handle nuclear disasters. On the other hand, in spite of

the attention given the incident and whatever its seriousness may have been, no documented negative health effects have been observed in the local population.

In closing this section on the unique aspects of hazards, it is important to point out that, from the public's point of view, volcanoes share some of the emergency response problems associated with nuclear power plant accidents. Volcanic eruptions are not common, particularly in the continental United States, and public experience with them is almost nil. Furthermore, public knowledge of the risks associated with volcanoes is limited and sometimes technically inaccurate (Perry et al., 1980a). In the case of volcanoes, however, there is an identifiable body of publicly accepted sources of information about the hazard. Thus, there is an available source of threat relevant data which the public may use in devising or arriving at situational definitions of threat.

Finally, the purpose of this discussion has been to document special aspects of hazards which may be helpful in interpreting human response data. As it was pointed out, the simple presence of some unique characteristics does not justify separating the analysis of nuclear and nonnuclear disasters. Instead, such distinguishing features should be acknowledged and treated as factors deserving special attention in the context of comparing human response to nuclear and natural disasters. The following chapter presents descriptive data on each of the disaster events to be compared and relates a largely nontechnical account of the circumstances surrounding disaster impact. The purpose of these descriptions is twofold: to provide an overview of the disaster incident and to convey general information which will make interpretations of between-event comparisons more meaningful.

CHAPTER THREE

THE DISASTER EVENTS

This report compares selected aspects of human response to volcanic eruption, riverine flooding and a nuclear power plant accident. The following descriptions provide an overview of the disaster in each relevant community.

Volcanic Eruption

Late in March, 1980, Mt. St. Helens, Washington, resumed volcanic activity after 123 years of dormancy. In general the public responded with excitement and curiosity to this activity. News media devoted much attention to the small steam and ash eruptions. As it became apparent that the volcano was not going to settle quietly back into dormancy, public officials in the surrounding counties and in several federal agencies developed or strengthened existing emergency plans. Scientists, particularly those from the U.S. Geological Survey, provided information to the media and officials concerning likely scenarios of future volcanic activity. The Cowlitz County Sheriff's Office prepared a pamphlet describing their warning system and distributed it to residents along the Toutle and Lewis River drainage areas.

The public maintained a high level of interest throughout this six week period from initial activity to the cataclysmic eruption, fostered in part by the media's attention on the volcano. While there is some evidence that citizens in the vicinity of the mountain were concerned

that specific contingency plans be developed and that officials be prepared for a major eruption (Perkins, 1980), there is also evidence that the public felt officials were too restrictive in their policies concerning access to the volcano. Cougar residents, for example, were reported as being angry by the roadblocks which cut their town off from a "booming" volcano business (The Columbian, 1980:20).

The cataclysmic eruption began when an earthquake of approximately magnitude 4.9 was recorded at 8:32 a.m. on Sunday, May 18th (Rosenfield, 1980:498). This earthquake apparently triggered a tremendous landslide on the north side of the volcano which led immediately to the explosion (Geophysics Program, 1980:530). A member of the U.S. Geological Survey volcano team described the eruption in detail, writing that this avalanche was, within seconds, overtaken by a large laterally directed blast that exploded out, with hurricane force winds, more than twenty kilometers from the volcano's summit (Christiansen, 1980:532). The avalanche then formed a debris flow that mainly turned and flowed down the valley of the North Toutle River for 18 kilometers. The displaced water of Spirit Lake, the melting blocks of ice from the former glaciers on the volcano's north flank, water from the displaced river bed, and melting snow and ice on the volcano's remaining slopes produced mudflows that flooded the debris flow and generated floods all the way down the Toutle River, the Cowlitz River and eventually the Columbia River (cf. Christiansen, 1980:532). These mudflows and floods destroyed bridges, roads and homes and filled the channel of the Columbia River, temporarily stranding ocean-going ships upstream in the Port of Portland.

The effects of the eruption were tremendous. The once symmetrical 9,671-foot peak now has a rim that reaches a reported 8,400 feet at its highest point. The north flank opening to the crater is now at about the 4,400 foot elevation (Korosec et al., 1980:16). The blast destroyed 150 square miles of forest, killing vegetation and wildlife. Sixty-eight people have been listed as killed or missing. Three billion board feet of timber valued at approximately $400,000,000 were damaged or destroyed (U.S. Senate Hearings, 1980:151), 169 lakes were either moderately damaged or destroyed, and over 3,000 miles of streams are either marginally damaged or destroyed (U.S. Senate Hearings, 1980:139). In total, after the first two major eruptions (May 18 and May 25) it was estimated that damages totaled more than $1.8 billion in property and crops; this included damages in the vicinity of the volcano as well as those areas that suffered from the ash fall (U.S. Senate Hearings, 1980:18).

Toutle and Silverlake, Washington, constitute adjacent unincorporated areas in Cowlitz County approximately 25 miles northwest of Mt. St. Helens, situated along the Spirit Lake Highway. Year-round area residents are for the most part involved in some aspect of the logging industry. The other mainstay of the local economy is tourism. Toutle and Silverlake are located just north of the point at which the north and south forks of the Toutle River join. The area's population is relatively small, approximately 1,500.

Few people in the Toutle/Silverlake area reported hearing any noise from the initial eruption at 8:32 a.m. on May 18. For most the first evidence of the eruption was the huge mushroom-shaped ash cloud which

filled the horizon to the south. Residents reported feeling a dramatic increase in temperature; with it came the sounds of trees and automobile windshields cracking from the heat. The area also experienced light ash fall; the ash cloud reached Silverlake about one and a half hours after the eruption (Korosec et al., 1980:14). The most serious threat, however, was from mudflows and flooding.

After the blast, the water temperature in the Toutle River rose above 80 degrees farenheit; these temperatures and the mudflows contributed to the destruction of most of the anadramous fish in the river. The mudflows and floods caused the river to rise well above its banks. Seven state highway bridges and numerous county and private bridges over the Toutle were destroyed, as well as almost 300 homes in low-lying areas nearby the river. Fortunately, most of the communities of Toutle and Silverlake lie on the slopes above the Toutle River and were minimally affected by the mudflows and floods.

Official concern about flood danger along the Toutle remained high for the several days immediately following the eruption. The eruption had raised and reshaped Spirit Lake which fed into the north fork of the Toutle River. Down valley from Spirit Lake, a large debris flow raised the valley floor of the South Fork Toutle River by several hundred feet for a distance of about 14 miles. At first the massive debris flow was thought to be only marginally stable, but a study of the deposit by soils engineers concluded that there was virtually no possibility that it would become remobilized and move on down valley.

Most residents were alerted by Cowlitz County Sheriff's officials of the initial eruption. The deputies drove predesignated routes, using their high-low sirens and their public address systems. A telephone

ring-down system was also implemented, again in predesignated areas that had a high probability of flooding. Although the Toutle Fire Department did not receive official notification of the eruption from the County Sheriff's Office, as had been arranged in pre-eruption planning meetings, once there was physical evidence of the eruption Fire Department volunteers assisted in the warning. They also helped man the roadblocks to keep sightseers out of the area. A large proportion of the residents evacuated, a process which was facilitated by unfounded rumors that a cloud of poison gas was moving toward Toutle and Silverlake.

Flood Events

Our data on flood events are drawn from three cases. The floods affected three communities of similar size. Each incident also involved similar disaster characteristics; in all three cases, authorities were forewarned and issued pre-impact warnings to citizens, evacuations successfully occurred, and duration of impact was approximately the same. In subsequent comparative analyses, data from these three events will be pooled to represent flood response information. In this chapter, however, a separate overview is given for each event.

Valley

Valley is a small community on the Platte river a few miles northwest of a major midwestern rail and commercial center. The community is sustained by railroad interests, a large manufacturing firm, and some

agricultural and livestock enterprises. Valley has a long history of spring floods. After a severe incident in March 1912, construction began on a levee system along the Platte which was completed in 1919. Levee failures that resulted in flood waters reaching Valley have occurred only three times since the 1912 flood; these were during 1948, 1960 and 1962.

In mid-March of 1978, the national Weather Service issued a flood watch for the lower Platte, bringing to the attention of the news media the presence of ice jamming and lowland flooding along the river. Although attempts were made to break up the ice, rising water resulted in the erosion of Union Dike located approximately three miles north of Valley on the evening of March 19. This marked the beginning of the most severe flood in the town's history. Although there were no deaths, property damages were extensive; damages to railroad equipment alone exceeded two million dollars. Most of the private residences in Valley experienced some water damage, ranging from basement flooding to major structural failure. Water, sewer and natural gas lines were damaged and services interrupted. These problems kept most residents from their homes at least 48 hours and many could return only after four to five days.

Virtually all of the town's residents received advance warning of the flood. On Saturday, March 18, the Volunteer Fire Department initiated patrols of the levee which protects Valley. Thus, when Union Dike began to crumble on the evening of the 19th, the problem was detected promptly and warning radioed to Valley as well as other nearby communities. Water did not reach Valley for approximately three hours. In town, a command post was organized at City Hall. The fire and police departments

contacted appropriate outside agencies for help and coordinated all emergency services in Valley. Warnings to evacuate were issued via public address systems on emergency vehicles and door-to-door. Civil defense sirens were also used to issue an evacuation alert. Most residents were warned a minimum of 30 minutes prior to flood impact and some had as much as 3 hours notice. These remarks refer to a warning to evacuate because of imminent danger; the mass media had "warned" that the ice jams could produce flooding for two days prior to impact. Approximately 90 percent of the households and one large nursing home were evacuated by the next morning. About three-fourths of these evacuations were accomplished prior to impact.

The Red Cross and Salvation Army provided shelter for evacuees, first in Valley itself, then in nearby towns when high water required relocation. More than 650 families registered at the Boys Town shelter established by the Red Cross. Length of stay at the shelter tended to be quite short. Many families stayed only long enough to assess damages to their homes and arrange to stay with relatives or friends in nearby communities. Most people were gone from their residence at least four days, the period necessary to reestablish basic services in the community.

Fillmore

Fillmore is a Western community of about 8,500. The citrus and railroad industry are major local employers. The community is located near the Santa Clara River, where it is joined by a tributary, Sespe Creek. The Sespe has flooded at least six times since 1962, the greatest

damage being inflicted in 1969. Although flood control plans for the Sespe are currently being considered, at the time of the flood no man-made levees existed in the area around Fillmore.

Early on the morning of March 4, 1978, the Sespe, swollen by nearly nine inches of rain in a 24 hour period, began to overbank. As the banks began to fail, the Sespe in effect was diverted through the west end of Fillmore. To make matters worse, Highway 126, which connects Fillmore with nearby towns, is a raised highway. Debris accumulating under the bridge dammed the Sespe, creating a lake in the low-lying areas. When the highway was bulldozed to stop the formation of the lake, at least one main phone line was severed, considerably increasing the extent of Fillmore's isolation.

Flood damages in Fillmore exceeded six million dollars. Nearly 200 homes sustained major structural damage and approximately 1,200 people evacuated from their homes. Most of the damage and half of the evacuations occurred in the extreme west end of town. One man was killed when his home collapsed due to water erosion.

Warnings to evacuate in Fillmore were delivered by police and fire department personnel both door-to-door and by public address systems from patrol cars and helicopters. The process of warning residents began at approximately 6:00 a.m. on March 4; the flood waters reached a peak at about 2:00 p.m. the same day. Most evacuees were directed to a Red Cross shelter located in a nearby school gymnasium. By the evening of March 4, police cordoned off the flooded area to maintain security, and evacuees were prevented from returning to their homes until the following day.

Snoqualmie

Approximately 1,300 people reside in the northwestern U.S. town of Snoqualmie which is situated along the south bank of the Snoqualmie River. The town is supported primarily by the timber products industry and some tourism. Snoqualmie and surrounding communities have historically been subject to late fall and winter floods. An extensive monitoring system, operated by the county, exists on the Snoqualmie River and advance warning of imminent flooding is provided directly to emergency services offices in threatened communities.

On December 1, the County Flood Control office informed Snoqualmie officials that the river was rising and that flooding was very likely to occur. Fire Department volunteers began a twenty-four hour "river watch" immediately, and just after midnight on December 2, a warning to evacuate was issued to residents of low-lying areas. The area to be warned contained approximately 200 households.

Warnings were delivered by fire and police department personnel using several methods. Initially, street public address systems and door-to-door contacts were used. Some telephone contacts were also made and authorities acknowledged that considerable informal "word of mouth" warnings were exchanged among neighbors.

In Snoqualmie the local high school and a large church are designated in emergency plans as shelters. Families for whom official transportation was provided were taken to one of these locations. Most evacuees provided their own transportation, however, and tended to go to the homes of friends or relatives. Most evacuees could return to their

homes within twenty-four hours. A Red Cross shelter, where evacuees could obtain vouchers to pay for lodging and meals, was established at noon on December 2, but was sparsely utilized.

Flood damages in Snoqualmie were comparatively low: approximately $500,000. About 80 dwellings were damaged by flood waters, as well as local bridges and roads. The damage figures are low because most commercial and industrial enterprises are located on high ground. There were no deaths or injuries as a result of the flooding.

Nuclear Power Plant Accident

The reactor accident at Three Mile Island (TMI) is probably best described as an extremely complex event which has been the subject of volumes of description in the print and broadcast media, as well as a number of technical and scientific studies (cf. Kemeny, 1979; Martin, 1980). Technically, of course, TMI was not a disaster; the major environmental release of radiation which would constitute a disaster was precluded. The situation may be technically characterized as an emergency, however, and the evacuations which occurred in connection with the nuclear threat may be compared with evacuations in the face of other threats. To attempt a brief overview of the event itself is a difficult undertaking, and by necessity must focus upon a few milestones rather than trying to portray each facet of the incident. This overview concentrates on milestones associated with three general human response issues: the nature of warning information disseminated; the communication system for dealing with the public; and the outcomes of the incident itself.

The accident at Unit Two of TMI began at approximately 4 a.m. on March 28, 1979, with a malfunction which disabled the reactor's pneumatic control system. The accompanying heat and pressure, coupled with a mechanical failure, resulted in hundreds of thousands of gallons of radioactive water being pumped into the containment building, and then into an adjacent auxillary building. The ventilation system in this auxillary building pumped some of the highly radioactive gases which accompanied the water into the atmosphere. At approximately 6:50 a.m. radiation alarms sounded and reactor operators declared a site emergency.

After the site emergency was declared, the notification process was initiated and contacts were made with local, county and Pennsylvania State authorities, as well as regional and headquarters offices of various federal agencies: the Nuclear Regulatory Commission, Department of Energy, Defense Civil Preparedness Agency, Environmental Protection Agency and Food and Drug Administration.

For the rest of the day, Wednesday and Thursday, contacts and information exchanges, involving many conflicting and garbled messages, took place among Metropolitan Edison officials, reactor operators, county, state and federal agencies and the Governor's Office (cf. Martin, 1980:47-130). Representatives of the national and international mass media converged on the site (Sandman and Paden, 1979). Pennsylvania Emergency Management Agency and county officials were advised of a possible need for evacuation of civilians and began preparing for such an eventuality. Although "reactor technicians suggested that the machine was under control and slowly returning to normal," some local residents began to leave the area (Chenault, 1979:5).

On Friday morning at approximately 8 a.m., a significant release of radiation was detected and a general emergency was declared at the site (Donnelly and Kramer, 1979:23). This release was apparently "uncontrolled" and further uncontrolled releases were believed to be possible. Information was released to the NRC regarding the presence of a hydrogen gas bubble in the reactor which was growing in volume and making the task of cooling the core more difficult (Martin, 1980:229). At approximately noon, Governor Richard Thornburgh issued an advisory that pregnant women and small children living within five miles of TMI evacuate and people living within a ten mile radius should stay indoors (American Nuclear Society, 1979:4). Following this Friday evacuation advisory, approximately 12,180 persons living within five miles of TMI and 31,360 persons living within a five to ten mile ring evacuated (Flynn, 1980:16). These figures represent 35% of the total population within five miles and 25% of the total population of the five to 10 mile ring. The number of representatives of Federal agencies at the site continued to grow; by Friday evening 83 NRC personnel were either on site or in the area (Donnelly and Kramer, 1979:23).

By Saturday official concern about the hyrdrogen bubble was increasing. At approximately 2:30 p.m. Chairman Joseph Hendrie of the NRC held a news conference and announced that the hydrogen bubble could potentially explode. Federal and state officials discussed the possibility of extending the plans for potential evacuation to a twenty mile radius around the reactor site. The spontaneous (that is, not officially ordered) evacuation of citizens living near the power plant continued. By late afternoon, NRC staff determined that the hydrogen

bubble could not explode; NRC representatives Harold Denton and Governor Thornburgh held an 11 p.m. news conference to announce this and President Carter's visit on Sunday (cf. Martin, 1980:230).

By Sunday, April 1, it was determined that the hydrogen bubble was shrinking and that the reactor appeared to be stable (Donnelly and Kramer, 1979:22). President Carter made a well publicized visit to the reactor site. Evacuation readiness preparations were continued in nearby counties.

On Monday it was announced that the hydrogen bubble had shrunk to 150 cubic feet and was still diminishing (Martin, 1980:231). Civil Defense officials noted that large numbers of citizens had already evacuated the area and absenteeism was creating labor difficulties in Harrisburg (Donnelly and Kramer, 1979:22). County and State authorities continued to formalize plans for possible evacuations and the Food and Drug Administration recommended that potassium iodide tablets be distributed. Late Monday evening the situation at the reactor had stabilized enough that the NRC agreed to let Metropolitan Edison allow the reactor to cool without depressurization.

By Tuesday, the crisis had begun to subside. The hydrogen bubble had significantly reduced in size, thereby reducing the likelihood that any evacuation of the general population would be necessary. Schools located near the TMI site were reopened on Wednesday. People who had left the area began to return home. It is estimated that 144,000 people living within a fifteen mile radius evacuated their homes at some point between March 28 and April 3; this is approximately 39 per cent of the total population (Flynn, 1979:14). On April 9, Governor Thornburgh advised pregnant women and young children to return to their homes.

The precise severity and consequences of the reactor accident are difficult to assess, even two years after the event. While the potential for human deaths and environmental contamination is very high in reactor accidents, there were no deaths at TMI and comparatively little environmental contamination. It was estimated that, as a function of atmospheric releases, persons living within a 50 mile radius of TMI received an average radiation dose equal to about one per cent of the annual background radiation level; persons living within five miles received an average dose of about 10 percent of the annual background level (Kemeny, 1979:34). Even allowing for errors in measurement, these doses are so small that the President's Commission on the accident reported that there will be no detectable physical health effects. Three TMI employees received larger doses during the course of the accident, but even these doses were not major. Transient mental health disorders were believed to be "the major health effect" due to the accident (Kemeny, 1979:35). No evacuations were officially "ordered"; an advisory was issued for pregnant women and school children. While physical damage to the TMI reactor was extensive, the major consequences of the accident appear to be related to identifying specific improvements necessary in the capability to respond to power plant emergencies at all levels.

CHAPTER FOUR

COMPARISONS OF WARNING SOURCE AND CREDIBILITY

The sources from which citizens receive information regarding the disaster event and their assessment of these sources are important in understanding patterns of evacuation behavior. Disaster research in general has shown that the source from which disaster warning information is received is related to how the warning and the hazard are evaluated and what immediate reaction is undertaken (Perry, et al., 1980a:73; Windham et al., 1977:39; Mileti and Harvey, 1977:5; McLuckie, 1970:38). Furthermore, the importance of a warning source shows up in a variety of contexts. For example, knowing the source from which individuals first received information regarding a disaster event can be used to draw inferences about (1) the response capacity of the emergency preparedness systems, and (2) the relative speed with which different communication channels to the public operate.

Also, research shows that a first step toward getting citizens to evacuate is accomplished when the individual receives a warning message from a source perceived to be credible (Perry, 1979; Mileti, 1975:210; Anderson, 1968:299; Williams, 1964:94; Janis, 1962:59). Studies of the differential credibility of warning sources provide feedback regarding whether or not the official emergency response system itself is credible, whether the way in which a particular warning was handled affected credibility, and to what extent other sources already viewed as highly credible might be incorporated into the emergency response system.

Understanding the differential credibility of sources also allows authorities to evaluate which ones are most useful for delivering immediate warning information regarding a disaster in progress and which ones are most effective for communicating information about ways of planning for and coping with a hazard or risk on a longer range basis. In this chapter we will compare source of first disaster information and source credibility among one nuclear and two nonnuclear events.

Source of First Information

Table 2 shows the source from which residents nearby the reactor at Three Mile Island first learned of the accident. The majority of respondents--69 percent--cited the mass media as first source, with most of these mentioning radio as the specific source. Virtually all other respondents--29 percent--first heard about the accident from a social contact, primarily friends, neighbors, relatives or job colleagues. Interestingly, almost no one reported that they first heard of the accident from an "official source"--that is, from a contact with emergency management personnel or a responsible local or state governmental official. At TMI, then, the mass media provided initial information to the largest proportion of citizens and social network contacts accounted for most of the remainder. This finding is in part a function of the nature of the accident: it was completely unanticipated and the seriousness and likely consequences of the accident for the public were unclear. Thus, the absence of forewarning meant no apparent time for emergency response officials to confer and communicate directly with the public. In performing a "notification function", the newsmedia

TABLE 2

FIRST SOURCE OF INFORMATION: THREE MILE ISLAND*

Source	N	%
Radio	186	52.0
Television	50	14.0
Newspaper	11	3.0
Radio Truck (Authority)	7	2.0
Friends/Neighbors	46	13.0
Job Colleagues/Employer	18	5.0
Other (Relatives, etc.)	41	11.0

*Adapted from Barnes et al. (1979:13).

broadcast routine notification to the public. Hence the first announcement made by Lt. Governor William Scranton in effect simply informed the media of the accident, without describing the role to be played by state or local emergency response professionals.

Table 3 shows source of first information for the two nonnuclear disasters: the May 18 eruption of Mt. St. Helens volcano and the floods. These data show a very different pattern by which citizens first heard of the disaster events. In each type of disaster, most respondents--nearly half--first heard of the event from local emergency response authorities. The next largest proportion of citizens, again in both disaster events, cited social networks (neighbors, friends or relatives) as the first source of information. The mass media accounted for only a small proportion of the first contacts. These findings represent a reasonably common pattern of first source contacts in natural disasters (Perry et al., 1980a): emergency response authorities constitute the first and primary sources of information, supplemented by informal contacts in overlapping social networks. The pattern sometimes varies with higher dependence on social networks when the disaster occurs with no forewarning. In natural disasters, however, little forewarning rarely results in heavy dependence on mass media.

To a certain extent, the differences in patterns of first warning source between TMI and the natural disasters may be understood in terms of the forewarning issue. However, the differences point to an important control distinction in the pattern of the emergency response to the two types of disaster. In natural disasters, control and communication tend to remain with local authorities and the mass media play a less distinct role during the emergency time phase. Even in the case of brief

TABLE 3

FIRST SOURCE OF INFORMATION: NONNUCLEAR DISASTERS

	Volcano		Flood	
Source	N	%	N	%
Neighbor/Friend	21	23.3	107	24.7
Relative	13	14.4	60	13.9
Local Emergency Authorities	38	42.2	209	48.3
Mass Media	9	10.0	49	11.3
State or Other Authorities	3	3.3	0	0.0
Saw Eruption or High Water	6	6.7	8	1.8

forewarning when authorities may not be highly visible initially, they tend to assume generally undisputed control of communications and disaster operations early in the emergency period. Two important factors in this control are that in natural disasters: (1) technical status reports on the disaster go from experts to emergency response authorities who incorporate the information into their plan and interpret the data for the public, and (2) emergency response authorities are traditionally visible to and recognized by the public as being responsible for protecting the citizenry. The consequences of having visible emergency response authorities in control is that it enables the public to define the disaster as an event which can be managed to an acceptable outcome. This is a function of the fact that the public sees familiar authorities, performing their expected role as emergency responders, who communicate disaster relevant information via traditional emergency communication channels.

In contrast, from the public's point of view, there was considerable question throughout the accident regarding exactly which agency was fully in control at TMI. Interestingly, the finding that most people first heard about the accident from the mass media foreshadowed the subsequent reliance on the mass media as a communication channel to the public by virtually all parties. As Chenault and his colleagues (1979:124) note:

> There is little to suggest, however, that the Public Information Office position was an especially prominent one in the activities of any county [Emergency Management Office]. The media-contact aspect of the public information task was taken up by the Governor's and Lieutenant Governor's offices, by the Public Information Officer of PEMA, and by County Commissioners and the County Coordinators.

Of course, many factors influenced public perceptions of the emergency response efforts at TMI, including high visibility of political figures coupled with lower relative visibility of traditional emergency response personnel, and real conflict among responder agencies. The use of the media, however, as a main communication channel to the public probably exacerbated (and no doubt sometimes exaggerated) problems of control.

When the mass media were chosen by political officials as a communications channel, they were in effect spotlighted for the public as a source of information. The problem which arises here is that, when emergency response information is involved, mass media are a *communication channel* with a considerable amount of "built-in noise". That is, in the context of conveying the official message, the media can be expected to comment on it editorially. That is, the media serve both a "notification function" and pass on information, but the media also serve a "journalistic function" vis a vis the public.

When officials attempt to communicate disaster relevant information largely through press conferences, they appear (to the public) to be officially sanctioning the mass media. It must be remembered that while the media do disseminate the official message, they are also likely (even obligated) to run a variety of related stories at the same time. Such related stories may or may not be consistent with the official message and may or may not be technically correct. The impact of these circumstances is that the public is confronted with many messages, possibly conflicting, all presumably from knowledgeable sources. The public does not get, in

straightforward form, the official message which is presumably based upon the authorities' plan for an integrated response to the emergency. In effect, the public is confronted with many spokesmen who have many messages and it is difficult for citizens to determine just what response is desired of them.

Source Credibility

Use of the mass media as a primary channel for communicating emergency response information to the public also has an effect upon the perceived credibility and usefulness of all information sources. Table 4 shows citizen evaluations of the usefulness of the information disseminated from eleven sources. Respondents were asked to classify the utility of each source into four categories: "extremely useful or useful;" "of some use;" "totally useless;" or "don't know about the source."

The ratings given these sources group them into four categories. Local television and radio were rated highest, with 67.0 per cent of the respondents rating each source as extremely useful or useful. The second highest utility ratings went to the Governor's office, network television, newspapers, and the NRC. The Governor's office and the NRC were rated as extremely useful or useful by 57.0 percent of the respondents, network television was given this rating by 55.0 percent and newspapers by 50.0 percent. It should be noted that for all six of these sources, most citizen ratings are at least as high as "of some use;" very few people rated any of these sources as useless. Citizen judgements were predominately positive for each of these sources.

TABLE 4

UTILITY OF INFORMATION FROM SOURCES: THREE MILE ISLAND*

Source	Extremely Useful or Useful	Of Some Use	Totally Useless	Don't Know
	Percent of Respondents Answering:			
Governor's Office	57.0	27.0	13.0	4.0
Nuclear Regulatory Commission	57.0	25.0	11.0	8.0
State Emergency Agencies	40.0	27.0	22.0	11.0
Local Government	36.0	27.0	27.0	11.0
Metropolitan Edison	11.0	18.0	60.0	11.0
Newspapers	50.0	31.0	14.0	6.0
Local Television	67.0	20.0	9.0	6.0
Radio	67.0	20.0	7.0	7.0
Friends	30.0	27.0	38.0	5.0
Relatives	30.0	21.0	40.0	8.0
Network Television	55.0	25.0	15.0	5.0

*Adapted from Flynn (1979:23-26).

There is considerably more variance in ratings for the two lowest rated groups. State emergency agencies and local government were rated as extremely useful or useful by 40.0 and 36.0 percent of the respondents, respectively. This indicates that the public rated these sources as moderately useful. One must balance this positive judgement, however, by acknowledging that 33.0 percent (emergency agencies) and 38.0 percent (local government) of the respondents rated these sources as either totally useless or "don't know the agency". Hence, roughly equal proportions of citizens saw these sources as being on opposite ends of the utility scale.

The lowest rated grouping is composed of friends, neighbors and relatives. An inspection of the row percentages in Table 4 shows that the modal rating for these sources is the category "totally useless". While in each case about 30.0 percent of the respondents saw these sources as useful, there is a definite skew in the direction of being perceived as of less use than the other sources. This is not a particularly surprizing finding for two reasons: (1) the highly technical nature of the emergency was such that one would not expect most citizens to have special information; and (2) friends and relatives were not useful in suggesting new interpretations or providing new information because the mass media was already doing so on a frequent basis and very thoroughly.

Finally, the lowest rating was given to Metropolitan Edison. This source was rated as totally useless by 60.0 percent of the respondents. An additional 11.0 percent of the respondents claimed not to have enough information to even rate the utility.

To summarize this discussion, the mass media are rated as the most useful sources of information. Local television and radio received the highest ratings, followed by network television, newspapers, the Governor and NRC. Substantially below this high grouping of six sources, we find the state and local authorities. Social network contacts (i.e., friends and relatives) rated lowest among the four groupings of sources, and Metropolitan Edison received by far the lowest utility rating.

Given the consistently high ratings assigned the mass media, it is difficult to judge the relative perceived usefulness of the other sources. Table 5 shows citizens' selections of a single most reliable scurce from a list which did not include mass media. When asked to chose among non-media sources, 58.0 percent of the respondents selected the NRC spokesman, Mr. Harold Denton, as the most reliable source of information. This rating sets the NRC clearly apart from all other sources which received negligible endorsements except for Governor Thornburgh, who was seen as most reliable by 19.0 percent of the respondents. It is interesting that when given this list of sources, 9.0 percent of the people answered that there was no source of reliable information. Respondents also rated local emergency response authorities very low as reliable sources, putting them in essentially the same category as Metropolitan Edison and friends/neighbors.

Table 6 shows the most reliable source chosen by citizens involved in the two nonnuclear disasters. In both types of disaster, the source most frequently selected as having greatest

TABLE 5

MOST RELIABLE SOURCE: THREE MILE ISLAND*

Source	N	%
NRC (Harold Denton)	207	58.0
Governor Thornburgh	69	19.0
Friends/Neighbors	8	2.0
Local Officials	7	2.0
Metropolitan Edison	6	2.0
No Reliable Information	31	9.0
Other	29	8.0
No Answer	2	1.0

*Adapted from Barnes et al. (1979:14).

TABLE 6

MOST RELIABLE SOURCE: NONNUCLEAR DISASTERS

Source	Volcano N	Volcano %	Flood N	Flood %
Neighbor, Friend, Relative	7	7.8	129	26.9
Local Emergency Response Authorities	33	36.7	266	55.4
State/County Emergency Authorities	1	1.1	18	3.8
Federal Authorities	11	12.2	0	0.0
Mass Media	20	22.2	38	7.9
Personal Judgement	18	20.0	29	6.0

reliability is local emergency response authorities. Indeed, more than one-third of those in the volcanic eruption and more than one-half of the flood victims placed their highest confidence in local authorities. For the lower reliability ratings there is a slightly different pattern between volcanoes and floods.

For the volcanic eruption, after local authorities, people listed most reliable sources (in order of descending confidence) as: mass media (22.2 percent), personal judgement (20.0 percent), Federal authorities (12.2 percent), and social networks (7.8 percent). This particular pattern of public confidence in different sources is probably best understood in terms of citizen perception of who controlled current and accurate information about the volcano. In these data, mass media refers largely to local radio. The fact that this source received the second highest confidence rating is a function of two circumstances: numerous volcano status bulletins were issued on the radio daily, and the emergency plan disseminated to the public by the County Sheriff's office urged citizens to monitor radio broadcasts. Under these circumstances, radio was seen by the public as having a defined role in an eruption response and could be perceived as an extension of local authorities. Personal judgement is rated as the third most reliable source. This degree of confidence in one's own judgement reflects the fact that volcanic eruptions were a very unfamiliar hazard; Mt. St. Helens had been dormant for 123 years. Respondents argued that the decision to leave their homes was a personal one, which they

felt had to be based somewhat on their own interpretation of the risk information given them by authorities (cf. Perry et al., 1980a:21).

In the case of flood victims, most of whom placed highest confidence in local authorities, the second most reliable source cited was social networks. Friends, neighbors, or relatives were chosen as the most reliable source by 26.9 percent of the respondents. As Table 6 shows, for floods social networks or local authorities account for virtually all of the respondents; a few selected state or county authorities, mass media, or personal judgement as most reliable, but these proportions are very small. The relatively high levels of confidence in social network contacts is related to citizens perceived importance of past experience as a basis for responding effectively to floods. In the United States, floods are the most widespread geophysical hazard (White, 1975), and consequently many citizens have been exposed to this hazard at one time or another. Hence, many private citizens, particularly those who have lived in an area for some time, can claim to have special knowledge of flood patterns. Many times, this type of information is passed around social networks in the form of advice about the threatening flood based upon a person's knowledge of previous floods.[1] Frequently flood coping information acquired in this fashion is useful and information recipients develop confidence in the source.

[1]Interestingly, from the standpoint of coping with a given flood situation, knowledge of previous floods is not always a technically accurate predictor of what is to come. (See for example, Perry et al., 1980b).

Summary

In these comparisons of public confidence in information sources, the important finding is that at TMI the public perceived the mass media as the most reliable source, while in the nonnuclear disasters the public placed highest confidence in local emergency response authorities. Furthermore, in both types of natural disasters, the proportions of people who chose local authorities as most reliable was considerably higher than the proportions choosing any other source. Local authorites were clearly the preferred reliable source.

With respect to the nuclear accident at TMI, it is possible to explain the observed pattern of public confidence in different sources by carefully examining events during the emergency period. Several factors are important in the high levels of confidence ascribed to the mass media. First, it was via the mass media that most people initially heard about the accident, and virtually all parties involved, particularly political officials, continued throughout the emergency to communicate with the public via mass media. Hence, with this official sanctioning, the public attended to the media and came to expect emergency information from this source. Second, TMI presented citizens with a threatening event that they had not previously experienced, which was complex and not easy to understand, and about which there was not a great deal of information available. In such situations, when no other source dominates the scene, the mass media are attractive to the public because they make available a variety of information from different

sources, all presumably with some special expertise. Third, the mass media, particularly radio and television, are available to the public on an almost continuous basis and therefore are presumed to have very current information. Finally, after the emergency when citizens try retrospectively to decide which source provided what turned out to best fit what happened, mass media have an advantage. This is because the media run many stories and accounts of the incident, and thereby have a greater likelihood of being correct just by chance. (If enough predictions are made, one of them is apt to be right.) Although this requires some selective recall on the part of citizens, it is not an unheard of phenomenon.

The problem of Metropolitan Edison's very low public confidence rating as a source of information is interesting, especially since the utility was probably the single source with the most technical expertise and special knowledge of the continuing status of the reactor. Probably the major contributor to the low confidence rating was the press conference held at 4:30 p.m. on the first day of the accident in which Lt. Governor William Scranton disassociated his office with the utility and stated that the utility was disseminating conflicting and misleading information about the accident (Kemeny, 1979:109). This public rebuke of Metropolitan Edison was undertaken by the State because it had evidence that Metropolitan Edison officials were misrepresenting the condition of the reactor and the resultant risks to the general public (Martin, 1980:107-108). As the President's Commission concludes: "Met Ed's handling of information during the first three days of the accident resulted in loss of its credibility . . ." (Kemeny, 1979:57).

Finally, we can address the question of why local emergency authorities at TMI were perceived as highly reliable by such a relatively small proportion of the public. Three general circumstances seem to contribute to this perception. First, apparently due to the active involvement of so many agencies and particularly political officials, local emergency response personnel played a relatively less visible public information role in the emergency. They were infrequently represented at press conferences and apparently appeared, at least to the public, to be performing support functions rather than a primary management function. Unfortunately, much of the massive planning efforts for 5, 10, and 20 mile evacuations by the counties were "invisible" to the general public. Second, there were very few direct communications between local authorities and the public. Counties did maintain rumor control centers and some distributed evacuation information to risk area residents; and if an evacuation had been ordered, provisions were made by locals for dissemination of the order and monitoring the exodus. As it was, however, there were no provisions by political leaders of federal agencies to routinely channel accident information intended for the public through local emergency personnel. Third, and largely because of the above described communication patterns, the public did not see local authorities as possessing any special access to technical information about the TMI event. Finally, based upon experience in managing natural disasters, it is likely that by not assigning local emergency

officials a more visible role, political authorities inadvertantly limited their credibility and contributed to the public perception that the accident was being poorly handled.

CHAPTER FIVE

EVACUATION DECISION-MAKING

After examining citizens' sources of information about the threats and their beliefs about the utility of these sources, it is important to consider how people acted upon the information available to them. Here we are concerned with one type of action: evacuation or relocation to an ostensibly safer place. This chapter reviews citizen answers to some general inquiries about why they did or did not evacuate in response to each of the three threats. In this way, one can gain perspective on the way citizens evaluated the threat through examining their beliefs about what made them act. This chapter is structured around three topics: reasons given for evacuating; reasons given for not leaving; and a discussion of the overall evacuation response.

Reasons for Evacuating

Table 7 shows reasons given for evacuating by people who left their homes in response to the reactor accident at TMI. In this case, respondents were read a list of possible reasons for leaving and asked, for each reason, whether it was important in their decision to evacuate. These data show that people's perception of danger by far dominated the reasons given for leaving. Situational danger was cited by 91.0 percent of the respondents as an important factor in the evacuation decision; this perception of danger is probably also a concern for the 61.0 percent who mentioned a need to protect children and the 8.0 percent who cited

TABLE 7

REASONS FOR EVACUATING: THREE MILE ISLAND*

Reason	Percent
Situation seemed dangerous	91.0
Information on situation was confusing	83.0
To protect children	61.0
To protect pregnancy	8.0
To avoid the confusion or danger of a forced evacuation	76.0
Pressure from someone outside family (friend/neighbor)	28.0
Trip planned before incident	5.0

*Adapted from Flynn (1979:18).

concerns about pregnancy. Confusing information about the threat was cited as a reason for leaving by 83.0 percent of the respondents. This confusion on the part of the public was no doubt related to the fact that different groups of presumed experts were disagreeing about the dangers involved and even the basic condition of the reactor. When the public lacks the technical skills to evaluate the disaster itself, and those who have the technical skills disagree, it tends to create relatively high levels of anticipatory fear, causing people to try to minimize their total potential losses. In this case, evacuation was seen as a prime path to minimization. The third reason for evacuating cited by a substantial proportion (76.0 percent) of people was to avoid the confusion associated with a forced evacuation. In this case, people were endorsing the belief that the situation was getting worse--it was only a matter of time till everyone would be told to go--and it seemed best to get "a jump on the situation" by leaving before exit routes became congested. Interestingly, relatively fewer people (28.0 percent) said that pressure from social network contacts contributed to their decision to evacuate.

Overall, the major concerns cited by evacuees focused upon the danger involved, the difficulty associated with obtaining clear, accurate information about the threat, and the likely problems of forced evacuation. To narrow this field down and assess the relative importance of different reasons, one can examine the single most important reason for leaving. Table 8 shows respondents' choice of a single, critical piece of information used in deciding to evacuate. These data show that concerns about situational danger were indeed paramount in the decision

TABLE 8

CRITICAL INFORMATION IN DECISION TO EVACUATE: THREE MILE ISLAND*

Information	Percent
Hydrogen Bubble	30.0
Conflicting Reports	19.0
Governor's Advice to Leave	14.0
Threat of Forced Evacuation	14.0
News Bulletins	9.0
Urging of Relative	6.0
No Single Reasons	25.0

*Adapted from Flynn (1979:22).

to evacuate: the largest proportion of evacuees (30.0 percent) said that the danger implied by the formation of a hydrogen bubble in the reactor was critical in their decision to leave. This factor is followed in relative importance by conflicting reports about the threat (19.0 percent), the Governor's evacuation advisory (14.0 percent), and concerns with a forced evacuation (14.0 percent). News bulletins from the mass media and urging from social network contacts were least frequently chosen as a most important reason for evacuating. Finally, it should be noted that for many citizens the presence of danger, conflicting information, an evacuation advisory, threat of forced evacuation, and other events had an additive effect: 25.0 percent of the respondents said it was a combination of factors rather than a single piece of information which was critical.

When the question of the most important reason for evacuating in nonnuclear disasters is considered, one sees a slightly different pattern. Table 9 shows volcano and flood victims' choices for the critical factor in the decision to leave. For both volcanoes and floods, the two reasons cited by the largest proportions of respondents as most important are (1) seeing evidence of the threat, and (2) being advised by officials to leave. Being able to see physical evidence of a threat in effect clarifies many questions a citizen may have about his susceptability. Indeed, when one can experience first hand such environmental cues, part of the problem of evaluating personal risk is transferred from technical experts to the citizen. He feels able to look at the situation and make a personal judgement about whether the threat is likely to affect him or his family and decide what protective action

TABLE 9

MOST IMPORTANT REASON FOR EVACUATING: NONNUCLEAR DISASTERS

	Volcano		Flood	
Reason for Evacuating	N	%	N	%
Neighbors/Relatives left	12	15.2	44	13.7
Media warnings	5	6.3	5	1.6
Officials urged departure	21	26.6	93	29.0
Relatives urged departure	16	20.3	28	8.7
Past experience	2	2.5	21	6.5
Saw eruption/high water	23	29.1	130	40.5

seems warranted. Research on natural disaster has shown that visibility of a threat is positively correlated with undertaking protective actions (Perry et al., 1980a; Perry et al., 1980b). Gruntfest et al. (1978) have documented, for example, that flash flood warnings issued in the absence of any visably threatening environmental conditions sometimes go completely unheeded. In effect, seeing environmental cues allows people to quickly arrive at a definition of the situation as dangerous and requiring special attention. Thus, if we group (as it seems reasonable to do) "seeing the threat" with belief that the situation is dangerous, one sees that perceived danger was cited as the most important reason for evacuating by those involved in both nuclear and nonnuclear disaster events.

The second most frequently cited reason for evacuation, again in both the volcano and flood data, was that the respondent was urged by officials to depart. These data reflect citizen confidence in officials as (1) having access to special hazard-relevant information, and (2) assuming responsibility for managing the emergency response efforts which involve the public. Under these conditions, citizens can define emergency officials as important sources whose advice constitutes information which should be acted upon. Although the proportions of respondents citing official advice as a reason for leaving are higher in the natural disasters, the official advisory from the Governor was the third most prominent reason for evacuating given in the TMI data.

For the natural disasters, the next most frequently cited reasons for evacuating relate to social network contacts: either the respondent witnessed neighbors and relatives evacuating or he was urged by relatives

to depart. In both natural disasters, media warnings and past experience were infrequently given by respondents as most important reasons for leaving.

In summary, situational danger and advisories from officials were cited most frequently as critical reasons for evacuating in both the nuclear and nonnuclear incidents. Indeed, these two reasons alone account for more than 55 percent of the volcano evacuees, 69 percent of the flood evacuees, and nearly 45 percent of the TMI evacuees. Also, media warnings were infrequently chosen as the most important reason for evacuating in all three hazards. It was found, however, that social network contacts were relatively more important to evacuation decision-making in the natural disasters than at Three Mile Island.

Reasons for Not Evacuating

Having reviewed reasons given as important in deciding to evacuate, we can now turn to another perspective and examine the reasons given for staying by people who chose not to evacuate. Table 10 shows the proportion of respondents at TMI endorsing each of twelve reasons for not leaving; note that respondents were allowed to select more than one reason for not evacuating. A fairly substantial number of respondents (62.0 percent) said that one reason they didn't evacuate was that they were not ordered to do so. Presumably, many of those who did not evacuate were waiting for an unambiguous directive from an authority. This is no doubt related to the fact that 42.0 percent of the respondents also said that the many conflicting reports about the threat were relevant to their decision to stay.

TABLE 10

REASONS FOR NOT EVACUATING: THREE MILE ISLAND*

Reason for not Evacuating	Percent of Respondents Endorsing
Not ordered to evacuate	62.0
Too many conflicting reports	42.0
No real danger existed	38.0
Home safe distance away	31.0
Fear of looting	24.0
No children involved	23.0
Could not leave job	21.0
Neighbors did not evacuate	16.0
Must care for farm	6.0
No place to go	5.0
Too old to leave	3.0
Handicapped	2.0

*Adapted from Zeigler et al. (1981:6).

The data in Table 10 suggest, however, that the most pervasive reason for not evacuating was the belief that no real danger existed. No fewer than five of the most frequently endorsed reasons make a reference to low levels of perceived danger. These are: no real danger existed, 38.0 percent; my home is a safe distance away, 31.0 percent; no children were involved (implying no danger to adults), 23.0 percent; and my neighbors didn't leave (thereby also believing the danger to be low), 16.0 percent).

Finally, although not prominent, fear of looting was cited by 24.0 percent of the respondents as a factor in choosing not to evacuate. Various logistical difficulties--job responsibilities, farm care responsibilities, no place to go, age, handicap--were also endorsed by a few respondents.

Table 11 shows the most important single reason given for not evacuating by volcano and flood victims. It will be noticed immediately that virtually all respondents in the volcanic eruption evacuated: only 10 people chose to stay in their homes. Thus, some care is required in interpreting these data. Confidence in the volcano data is enhanced, however, by the fact that the relative ranking of reasons for not evacuating matches the rankings in the flood data. As we found in the TMI data, the most prominent reason for not evacuating was the belief that no real danger existed. This reason accounts for 70.0 percent of the Mt. St. Helens nonevacuees and 67.5 percent of those who didn't evacuate in response to floods. The second most frequently cited reason for staying which together with no danger accounts for all of the volcano nonevacuees and nearly 80 percent of the flood nonevacuees is "stayed to

TABLE 11

MOST IMPORTANT REASON FOR NOT EVACUATING: NONNUCLEAR DISASTERS

	Volcano		Flood	
Reason for Not Evacuating	N	%	N	%
No evacuation order	0	0.0	3	1.8
Did not believe real danger existed	7	70.0	114	67.5
Feared looting	0	0.0	3	1.8
Stayed to help others	0	0.0	13	7.7
Family not together	0	0.0	3	1.8
Stayed to protect house	3	30.0	18	10.7
High water blocked exit	0	0.0	1	.6
Survived other floods unharmed	0	0.0	14	8.3

protect house". In this case, reference is made to protecting the house from the environmental threat, not from a threat due to looters. The problem of looting is generally rare in natural disasters (Quarantelli and Dynes, 1970:168; Dynes et al., 1972:33), and was not perceived as a reason not to evacuate in the data at hand.

In summary, one should remember that the reasons discussed above are those given only by people who chose not to evacuate. In their decision-making calculus, these factors were sufficient to make them believe that leaving was unnecessary. For both TMI and the natural disasters, most of those who didn't evacuate chose not to because they did not believe that real danger existed. Among nonevacuees at TMI, the presence of conflicting messages and the absence of an official evacuation order were frequently cited reasons for staying. In the natural disasters people also reported that they chose to stay so that they could protect their homes from the environmental threat. Unlike the natural disasters, fear of looting was given as a reason for not evacuating at TMI.

The Overall Evacuation Response

After reviewing reasons given by evacuees for leaving and by nonevacuees for staying, to gain perspective on the process of evacuation one can consider the overall public response. In general, particularly in natural disasters, getting people to evacuate is a difficult problem. Many people refuse to leave even when ordered to do so (Quarantelli and Dynes, 1972; Quarantelli, 1981:15-20; Quarantelli and Taylor, 1977; Quarantelli and Dynes, 1977). In the volcanic eruption studied here,

11.1 percent of the citizens at risk failed to evacuate. For natural disasters this is a low proportion of nonevacuees and has been explained in terms of the uniqueness of the disasters and the high levels of community emergency preparedness in the affected communities. The more commonly seen figure is that for the flood communities where 48.6 percent of those who received a warning failed to evacuate. At TMI, where only an evacuation advisory for pregnant women and young children was issued, it is estimated that 144,000 people,. 39.0 percent of the total population within 15 miles of the reactor, evacuated. This relatively high proportion of evacuees contrasts with the general situation in natural disasters and requires that one assess the probable reasons for this response at TMI.

The answer to the question of why so many people evacuated at TMI lies in an examination of two general categories of reasons: (1) largely circumstantial factors related to the way in which the emergency was managed; and (2) factors related to the public's perception of the risks involved in nuclear accidents.

With regard to managing the emergency, the situation at TMI was characterized by three elements. First, the public was faced with an unfamiliar risk which was difficult to understand. In the entire history of the United States nuclear program, prior to TMI only three times have there been equally serious reactor accidents and none of these involved radiation releases off-site (Donnelly and Kramer, 1979:3). Thus not only the public, but emergency management officials too, were not attuned to the problems of response to this kind of risk. Second, especially for the first three days of the emergency period, there appeared to the

public to be confusion among officials and many contradictory messages about the accident--its seriousness and the risks to the public--were disseminated. Therefore, the public was facing an unfamiliar hazard regarding which there were many conflicting assessments of danger. Third, however, there was one thing upon which most experts did seem to agree (which also made intuitive sense to the public): safety was correlated with increasing distance from TMI. Furthermore, this distance idea came up in the form of public discussions of evacuation by officials and experts a number of times during the emergency period. On the morning of the second day (Thursday), a physician being interviewed on Harrisburg radio recommended evacuation (Martin, 1980:125). Friday morning the Emergency Management Director of Dauphin County warned that an evacuation may be needed very soon; he also described things people should take with them and where they should go (Martin, 1980:144). Although this evacuation "advisory" was not made "official", that afternoon Governor Thornburgh did advise that pregnant women and small children evacuate. Also, in Dauphin, York, Lebanon, and Perry counties information packets (or instruction sheets) on evacuating--what to take, how to leave, where to go--were prepared and distributed directly to the general population (Chenault, 1979:124-129). To summarize, people were confronted with an unfamiliar risk, regarding which it was difficult to get information, but were told that evacuation was a definite path to safety. Put this way, it is less difficult to understand why a person seeking to minimize potential negative consequences would evacuate. While it is correct that an evacuation was never officially ordered, evacuation was sanctioned by experts as a protective action. Indeed,

while experts argued about whether the situation was so serious that people should evacuate, they agreed that evacuation would substantially reduce the danger. One would expect that these circumstances would encourage evacuations independent of the nature of the hazard involved, whether nuclear or nonnuclear.

The second category of reasons for evacuation at TMI, the public perception of the threat, depends largely upon what have previously been described as "unique" aspects of nuclear threats.

Table 12 shows citizen perception of the threat posed by TMI to the family for three different distances from the plant. These data show the proportions of people who rated the threat from TMI as very serious or, at the opposite end of the continuum, as nonexistant. First, the data indicate that distance did not seem to have an effect on perceived level of threat in the case of TMI: for all three distances about half of the respondents defined threat as very serious and just over ten percent saw no threat. Table 13 shows level of perceived threat for the two natural disasters classified into four categories of perceived danger ranging from "none" to "severe". A critical aspect of these data, in comparison to the TMI data, is that smaller proportions of people saw the natural disasters as posing severe danger and larger proportions endorsed the belief that the threat posed no danger. For both the volcano and floods, nearly half of the respondents said that the threat posed either no danger or slight danger. These data document that for some reason, citizens perceived the nonnuclear risks to be relatively less threatening than the nuclear risk.

TABLE 12

PERCEIVED THREAT TO FAMILY DURING TMI ACCIDENT*

Distance from TMI	Percent Very Serious Threat	Percent No Threat
0 to five miles	50.0	14.0
five to ten miles	50.0	11.0
ten to fifteen miles	47.0	11.0

*Adapted from Flynn (1979:30).

TABLE 13

PERCEIVED THREAT FROM NONNUCLEAR DISASTERS

Perceived Threat	Volcano N	Volcano %	Flood N	Flood %
Believed hazard posed no danger	28	31.1	99	20.7
Slight danger	16	17.8	146	30.5
Moderate danger	10	11.1	143	29.9
Severe danger	36	40.0	90	18.8

Although empirical assessments of perceived threat from nuclear disasters are virtually nonexistent, social scientists have argued that citizens have a distinct view of nuclear hazards as constituting a special threat different from other man-made and natural hazards (Perry et al, 1980:c). This view stems from public beliefs about the characteristics of radiation as hazard. Of interest here are two general types of belief patterns that relate to the problem of detection and the concept of dose.

In the case of natural hazards, such as tornadoes, floods, or volcanoes, people have a sense of what constitutes danger--wind, water, mud flows, ash, etc. These agents may not exactly be familiar, but neither are they completely outside the citizens realm of experience or imagination. Also, these risks are spatially defined in the sense that they are "visible" and finite; one can feel the wind or see the water or mud. A citizen, relying upon his senses--sight, touch, hearing, etc.--can reliably detect the presence or absence of such risks in the environment and, if need be, generate some protective strategy on his own, perhaps by seeking high ground or some special shelter. Hence, these types of risks can be perceived by citizens as identifiable, understandable, and as threats from which it is possible to protect oneself. Interestingly, this view of natural hazards has been cited as one of the reasons that citizens are slower to respond to disaster warnings than authorities deem appropriate.

On the other hand, studies show that the public views radiation risks as "involuntary, unknown to those exposed and to science, uncontrollable, unfamiliar, potentially catastrophic, likely to be fatal rather than

injurous, and dreaded" (Slovic et al., 1980:5). As a hazard, then, almost opposite qualities or characteristics are attributed to radiation than are attributed to natural disasters. Radiation tends to be viewed as an invisible, lethal threat that radiates in all directions from a source, against which protection is difficult or impossible to achieve. Hence, radiation is an unfamiliar danger which the citizen cannot see, hear, smell, feel, or taste (Grinspoon, 1964:120) without special equipment. The idea that a hazard, perceived to be very lethal, is for the most part undetectable distinctly sets it apart from other hazards.

With regard to dangers from the not easily detected hazard of nuclear radiation, most citizens are familiar with the rather dire nature of the consequences of exposure. The public has seen many discussions of death from radiation exposure, and studies indicate that people tend to associate death--either immediately, or within a few weeks due to radiation sickness, or in years due to cancer--as a consequence of such exposure (cf. Lifton, 1967:48-52; Kiyoshi, 1967:93-98; Slovic et al., 1980:8-12). There are, of course, many hazards in which exposure appears to result in death. With respect to radiation, however, the concept of dose or the extent of exposure is very important in determining the extent of negative consequences. In fact, radiation is present in much of the human environment; sensitive detection instruments must even be calibrated so that background radiation levels are accounted for in measurements. Humans are constantly bombarded by radiation--it is only when these levels of exposure become high that health consequences seem to accrue. The idea of dose does not appear to be fully appreciated by the public in that many people seem to equate any level of exposure with death, the most serious consequence.

It is very likely that people do not appropriately distinguish radiation from nuclear power plants from radiation associated with nuclear bombs. Indeed, when asked to describe health consequences of radiation exposure, people tend to mention symptoms common in exposure only to very high doses, such as one would experience if exposed to a nuclear bomb explosion. Parenthetically, dose levels as well as types of radiation are considerably different for nuclear power plant accidents than for weapons. The point of this discussion, however, is that the public in general sees radiation as a difficult to detect threat which produces very negative consequences in those exposed. This sets it apart from other disasters, particularly natural disasters, both in the way people think about it and in the way they react to possible exposure. As our data show the level of threat attributed to nuclear disasters is much higher than for the nonnuclear disasters. This heightened threat associated with the nuclear disaster is also no doubt related to the frequently cited "fear reactions" to nuclear disaster (Glass, 1956:630; Lifton, 1964:152); that such fear characterized citizens during the TMI incident was documented (as "demoralization") by the Report of the Public Health and Safety Task Force (Fabrikant, 1979:275) of the Presidents' Commission.

CHAPTER SIX

SUMMARY: IMPLICATIONS FOR EVACUATION PLANNING

This report represents a first, tentative step toward developing a reliable body of knowledge regarding the comparability of human response to nuclear and nonnuclear threats. At present, it is the only study available in the open literature which reports data based comparisons. The analyses presented in Chapters Four and Five exclusively focus upon two issues: warning source credibility and evacuation decision-making as seen by the public. These particular foci were chosen largely because analyses were confined to published data on the Three Mile Island accident. Regretably, no TMI data bases were available for a thorough secondary analysis.

The empirical comparisons which were possible, however, have important implications for evacuation planning procedures for nuclear threats. The importance of these implications lies not so much in the finding itself, but in the extent to which findings about special issues in natural disaster evacuations are applicable to the nuclear case. The following sections summarize a number of conclusions which may be drawn from the comparative analyses in Chapters Four and Five. These conclusions are discussed in terms of two general categories: implications of the comparisons of source credibility and implications of the study of evacuation decision-making. Finally, implications for further research are addressed.

Implications Arising from Source Credibility

- During the course of a nuclear reactor emergency, local emergency response officials should be integrated into the public information system and should constitute the public's primary source of official accident-relevant information. In the eyes of the public this enhances the authority and credibility of the local emergency response officials who will ultimately be responsible for the operations involved in getting the public-at-risk to undertake some protective action--whether it is evacuation or some other measure. By highlighting the role of local authorities, confidence in them is increased among the public-at-risk, which in turn promotes public compliance with emergency measues. Of course this does not mean that local officials should be the only information disseminators; it does require, however, careful coordination and cooperation among emergency response personnel at all levels--city, county, state, federal--and between emergency response officials and political officials at all levels. At TMI political officials initially assumed and retained the majority of the public information task.
- When an emergency--either nuclear or nonnuclear--is in progress, the mass media should not be relied upon as a primary communication channel to the public. The mass media constitute a communication channel characterized by considerable "noise"; juxtaposing "official" messages with other related messages (sometimes conflicting) promotes confusion in the mind of the public regarding exactly what response is required of them. In natural disasters,

the media have been effectively used as a supplementary source of information particularly when, as part of an established emergency plan, officials instruct citizens to monitor radio or television broadcasts for status reports regarding a hazard. In this case the role of the mass media is to provide the public with information about the immediate status of the hazard which allows the public to determine whether specific provisions of a community evacuation plan should be implemented. As part of the emergency plan for responding to the volcanic activity at Mt. St. Helens, for example, the public was instructed to monitor radio bulletins on the volcano's status (Perry et al., 1980a), and to evacuate specified areas in the event of an eruption alert.

- When an emergency is in progress, officials should distinguish the function of providing public information about the emergency from the function of sending messages which direct some emergency response. This helps the public to understand when they are expected to take an action and when they are not. As part of a public information function, officials can provide updates regarding changing conditions regarding the event, or describe a range of potentially useful measures where the decision to implement is left to the public. Although ideally such matters are addressed before a given disaster as part of a general community preparedness plan, public information during an incident might also include a description of what constitutes a warning signal and what should be done when such a signal is received. It is important, however, to separate such public information clearly from an

emergency response directive. This latter message is one which instructs the population-at-risk to begin a planned (and presumably coordinated) protective response; it is intended to evoke full participation rather than being an option for which the public is left to make a decision regarding implementation. When these two types of message are not carefully distinguished, particularly in the case of evacuations, the public can be expected to undertake a range of protective actions (some possibly substantially differing from the actions desired by officials) according to widely differing time schedules.

- In all disasters, particularly nuclear disasters, rumor control is a critically important function. In general problems associated with rumor control will increase to the extent that the disaster or hazard is less familiar to the public. In the case of natural disasters, officials are usually concerned with dispelling popular myths or technically inaccurate conventional wisdom regarding the event. In dealing with nuclear disasters the problem is even more pronounced, due to the aforementioned complexity of technology associated with the event, general unfamiliarity of the public with nuclear disasters, and the tendency of the public to define most radiation hazards relative to the health dangers associated with nuclear weapons. The importance of rumor control is underscored by the reported high utilization of public information telephone lines during the Three Mile Island incident.

- The public education function is a particularly important component of emergency response plans for dealing with nuclear power plant accidents. The time to explain the nature and specific dangers involved with a given hazard is before a crisis occurs. During the crisis official attentions should be devoted to achieving protection for the public; this function is unnecessarily complicated if the nature of the risks in general as well as those specifically involved in the immediate incident must be described. By attempting to run a "mini" hazard awareness campaign during an incident, authorities force the public into a general information gathering posture rather than allowing the public to assimilate and prepare to respond to a specific emergency management strategy. It is likely that much of what was described as confusion on the part of the public during the TMI accident was related to the fact that public education was being conducted simultaneously with crisis management. Numerous examples of public education strategies are available, both from natural disasters (Davenport and Waterstone, 1979) and Civil Defense (Perry et al., 1980c).

Evacuation Decision-Making

- Citizen evacuation response during nuclear disasters may be understood in terms of the same variables which explain evacuation in nonnuclear disasters. Several researchers have pointed to the relatively high levels of spontaneous evacuations at TMI and argued that because of this there must be something about nuclear disasters that makes people more responsive. The implication here

is that there is some unspecified basic difference between nuclear and nonnuclear disasters. The evidence marshalled in the present study suggests that the difference is the fear or dread characteristics (described as unique in Chapter Two) associated with nuclear disasters. The evacuation response at TMI can be explained using the same variables developed to understand evacuation behavior in other natural and man-made disasters. Thus, citizens evacuate when four conditions are met: (1) they have accounted for the safety of their immediate household, (2) they have been given--by authorities--or have personally developed a plan for protective action, (3) they believe that a threat does *exist in the environment*, and (4) they perceive that upon impact this threat could result in some level of damage to their person and property (see Perry, 1979; Perry et al., 1980a; Perry et al., 1980b). At Three Mile Island the nuclear nature of the threat meant that people perceived personal risk to be very high (condition four), but in general those who evacuated were people for whom all four conditions were met (cf. Zeigler, 1981).

- The high level of spontaneous evacuations around TMI appears to be related to the above described elevated perception of personal risk (threat) by the public. Although the same evacuation decision-making variables seem to fit both nuclear and nonnuclear disasters, in the nuclear case citizens apparently believed themselves to be at risk to a considerably greater extent. Thus, the perceived negative consequences associated with failing to undertake some protective action or doing so too late were

extremely high. In planning to manage nuclear disasters, one must be sensitive to the effects of elevated perceptions of risk, particularly since high levels of spontaneous or unsupervised evacuation are not necessarily desirable. Furthermore the presence of citizen beliefs that nuclear--radiation--disasters pose very high risks introduces a number of logistical and procedural implications for managing an evacuation:

(1) If authorities issue evacuation route and destination to the public early in an incident with instructions to wait until officially advised before leaving, citizens are likely to ignore the instructions and depart before being told to do so;

(2) Evacuation shadow effects will be multiplied. That is, when an evacuation is announced for a specific geographic area, it should be expected that residents who are nearby but still outside this area will also evacuate;

(3) Graded or group-specific evacuation orders--for example, for pregnant women and children under five years---will generate evacuations by others as well. In general, such orders that would otherwise divide families will be heeded at least by all members of a given family;

(4) Planning attention needs to be devoted to the problems associated with getting evacuees back to an area after they have been evacuated. Although not the case at TMI, if a significant radioactive release had caused citizens to evacuate it is not obvious that they would respond readily to an "all

clear" signal. A study should be made of how one should structure and disseminate a message that an area once threatened by radiation is now safe.

Although they are not directly derivable from the specific data presented here, two additional general conclusions may be inferred based upon the overall analysis. These conclusions have implications for the "dual-use" philosophy adopted by FEMA, and for the kind of organizational coordination required to effectively manage large-scale evacuations.

- The "dual use" philosophy appears to be founded upon reasonable assumptions in that the basic principles of human response to natural hazards also describe human response to nuclear threats. The data analyzed here indicate that with respect to warning source credibility and evacuation decision-making, the same theoretical propositions may be used to explain human response to threats associated with evacuation in two natural hazards and a nuclear power plant accident. It was established, however, that the analyst must document and allow for certain unique aspects of all disasters; it was found for example that public perception of threat tends to be elevated in nuclear threats.
- Inter-organizational and inter-agency coordination and preparedness for ordering and overseeing a mass evacuation are crucial problems in both nuclear and nonnuclear disasters. As Quarantelli (1980:149) has pointed out, at almost all jurisdictional levels such preparedness is poor, and the data examined here on TMI serve to further verify this hypothesis. It is particularly interesting to note that in the face of poor coordination among and guidance

from authorities, the public seems, to some extent, to be able to take care of itself. Remember that 39 percent of the population within fifteen miles of TMI managed to evacuate successfully with a minimum of guidance from authorities. This should not be interpreted, however, as evidence that in all disasters the public will survive with a minimum of help from authorities. Instead, it indicates that even in the absence of official coordination, the public is not reduced to panic flight or a total breakdown of reason (cf. Quarantelli, 1960). There is no guarantee that the remaining 61 percent of the population around TMI could have evacuated without some coordinated official intervention.

To describe the event accurately, it must be acknowledged that inter-organizational coordination did improve over time during the TMI incident. It seems apparent that some evacuations can proceed with a minimum of coordination by officials; this has been true for years in the relatively small and short-term evacuations associated with natural disasters in the United States. As the number of people involved and the time outside the risk area increases, however, it is less likely that mass evacuations can be smoothly executed without high levels of inter-organizational preparedness and coordination. It is likely that the number of spontaneous evacuees at TMI approaches the upper limit of the size of mass evacuation which can be accomplished in the face of relatively low levels of inter-organizational coordination. If we are to accomplish mass evacuations on the scale necessary to implement such programs as Crisis Relocation or as might be required in response to a

nuclear power plant accident involving a breach of containment, inter-organizational coordination among emergency management organizations must be substantially improved.

Implications for Further Study

It is interesting to note that most of the conclusions and implications discussed above are neither striking nor absolutely unique in the social science literature. In many cases, they reflect suggestions made in connection with research on a variety of disaster agents over the years. It is of course important to document empirically cross-disaster agent applicability of planning and citizen response principles, as this report did. However, given that much information is available from research on how people can be expected to respond to evacuation orders, how public information should be handled during disasters, how to issue and structure evacuation advisories and warnings, etc., it is interesting that apparently so little of this available information was utilized in the management of the TMI accident. Often planners and policy-makers read the conclusions of research reports and respond by saying, "I already knew all that". The experience at TMI, which also occurs in natural disasters, where various emergency management problems arose in spite of the availability of research-based planning and response principles which bear upon the issues causes one to look askance at such claims. More importantly, though, it raises questions about how research results are disseminated from researchers to planners and policy-makers, as well as how these latter actors evaluate and incorporate research information into the emergency management

process. Clearly, much information regarding emergency response performance of citizens that was available before TMI was not used in managing that incident. It may be that the research was not used because relevant officials were not aware of it, because it was not in a form which could be implemented, because it was not in a form which could be understood, or because the research was perceived to be irrelevant to the problems. The point is that to date little attention has been devoted to examining the channels through which research findings reach those people at different jurisdictions (local, state or federal) who would use them, and how feedback travels from users back to the research community. Understanding and perhaps formalizing such communication channels would seem to be one way to insure that research is relevant to planning and operational concerns and is presented in a fashion which lends itself to evaluation and utilization by policy-makers and implementers. Therefore, an important issue for further study is the process through which research results are disseminated to planners and policy-makers, and the factors which influence utilization patterns.

The data reported in Chapter Five indicated that levels of perceived threat were very high in the nuclear disaster relative to the two natural disasters. This finding is also supported by several attitudinal studies in the psychological literature which indicate that people view radiological hazards as particularly threatening and potentially very dangerous. Documenting that this differential exists, however, is only a first step toward understanding <u>why</u> people define radiaiton dangers as so threatening and the implications of this for the management of emergencies involving a nuclear component. A study of the calculus used

by citizens in assessing risks associated with radiation relative to other hazards--i.e., delineating factors which influence citizens definitions of risk--would provide a basis for making decisions about how best to communicate technical information on the forms and consequences of radiation such that citizens can make informed evaluations of risk. Furthermore, this type of study could lay the groundwork for addressing three related research questions.

- how to reduce the anxiety reportedly associated with nuclear disasters which is in itself harmful to the public and potentially could serve as a limiting factor on citizens' ability to comply with emergency instructions;
- how to address the problem (documented by research) of the public's tendency to equate radiation risks generated by nuclear weapons with the radiation risk associated with nuclear power plants; and
- what is the relationship among peoples' cognitive frame of reference, their verbally expressed attitudes, and their emergency response behavior, and what implications does this have for the design and implementation of emergency plans.

Finally, the data examined in this report indicate that there is a need for research on the design and implementation of both public information programs regarding nuclear disasters and dissemination programs for specific emergency response plans. Such research might appropriately address four general issues. First, one should begin to identify those channels through which risk and response information can be efficiently and effectively disseminated to the public as part of a long-term comprehensive program to enhance awareness of nuclear hazards.

Second, an attempt should be made to specify dissemination roles for different levels of cadre (e.g., federal, state and local authorities) in the United States emergency management system. Third, because the public tends not to distinguish among risks associated with different types of nuclear disasters--e.g., nuclear war, power plant accidents, radiological transportation accidents--it is necessary to devise a strategy to sensitize citizens to distinctions among them which have implications for the types of mitigation or emergency response behaviors which should be undertaken. Fourth, there is a need to devise a strategy for selecting which emergency response instructions, as well as what parts of existing emergency management plans, should be disseminated to the public. This would include decisions about what information should be part of a general public education program and what should be disseminated during the warning phase when disaster impact is believed to be imminent.

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Citizen Evacuation in Response to Nuclear and Nonnuclear Threats, by Ronald W. Perry. UNCLASSIFIED, Battelle Human Affairs Research Centers, Seattle, Washington, 98105, Sept 1981, FEMA contract number EMW-C-0296.

Abstract

This study describes the results of a comparative analysis of data on citizen evacuation behavior in response to nuclear and nonnuclear threats. Two issues in particular are examined: citizen warning source and perceived credibility of warnings, and evacuation decision-making processes. Three types of hazard are examined: the Three Mile Island nuclear accident, three riverine floods, and a volcanic eruption. The implications of the research findings for evacuation planning and operations are also assessed.

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